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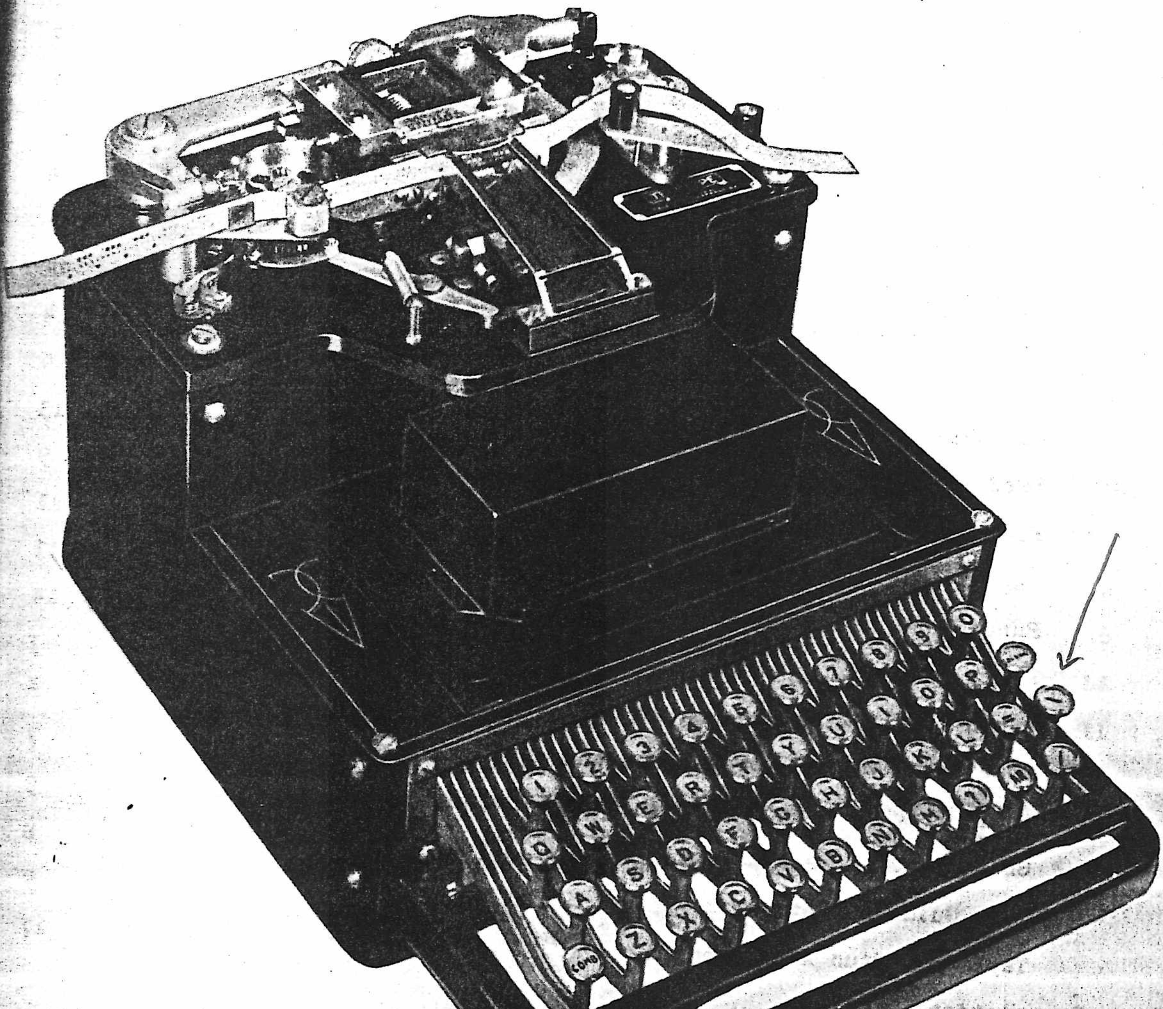
TELETYPE

PRINTING TELEGRAPH SYSTEMS

DESCRIPTION AND ADJUSTMENTS OF THE TELETYPE WHEATSTONE PERFORATOR

TELETYPE
CORPORATION
SUBSIDIARY OF
Western Electric Company
CHICAGO, U.S.A.

Printed in U.S.A.



DESCRIPTION OF THE TELETYPE WHEATSTONE PERFORATOR

GENERAL

The Teletype Wheatstone Perforator is a unit of apparatus that is used to perforate tape for automatic telegraph transmission. It is a self-contained, magnet (solenoid type) operated portable unit. It consists essentially of a set of key levers, a punch selecting mechanism, a punching mechanism, and a tape feed mechanism. When any key lever is depressed, corresponding groups of perforations that represent dot and dash character signals of the Continental Code are perforated in the tape. The perforated tape with the dot and dash character signals thus recorded may be fed automatically through a tape transmitting device, operating a recording instrument at a distant station.

The perforator is equipped with a power cord and attachment plug. D.C. power is required for its operation.

NOTE: In all the figures of this bulletin, fixed pivot points are designated by solid black circles.

Signaling Code

Two types of perforators are available: One known as the "Continental" type; and the other as the "Cable" type. These perforators use the so-called "Continental Code."

On the "Continental" type perforators, dots are represented in the tape by two holes, one of which is above the feed hole and the other directly below it. Dashes are also represented by two holes, one above the feed hole and one below, but the lower hole is positioned to the right of the upper hole (See Figure 1).

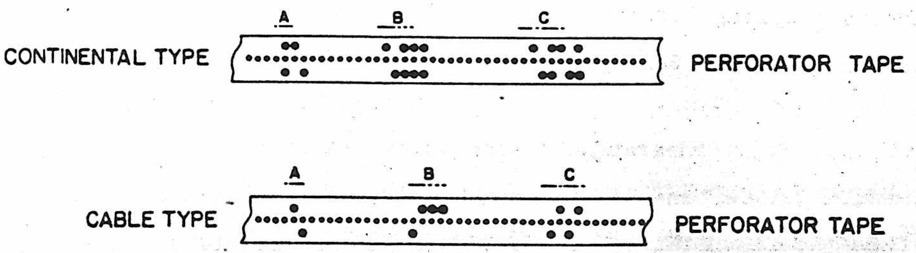


FIGURE I

"Cable" type perforators use the same code (i.e., Continental Code), but the dots are represented in the tape by only one hole which is located above the feed hole, and dashes are represented in the tape by one hole located below the feed hole.

Punch Selecting Mechanism

Each key lever operates a selecting bar located directly below it, which is held in line by guide projections attached to the sides of the key lever (Figure 2). A spring attached to the rear end of each selecting bar holds both the selecting bar and key lever in their unoperated positions. The lower edge of each selecting bar is notched in accordance with the code combination of the character represented. Located below the selecting bars and at right angles to them are the "T" bars. These bars move up and down in the slots of a guide comb. The vertical portion of each "T" bar has two parallel links pivoted to it (Figure 5), which cause the upper edge of the "T" bar to maintain a horizontal position throughout its travel. A connecting bar makes contact with each "T" bar through a slot in the vertical section

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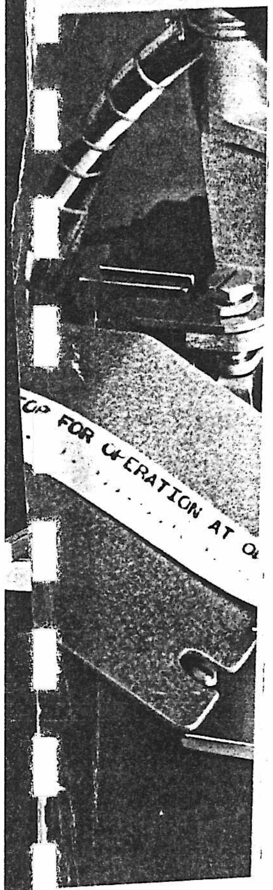

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of the "T" bar. A spring attached to the rear section of each connecting bar supports the weight of the "T" bar connected to the front end, and holds the "T" bar in contact with the selecting bars above (Figure 2). A connecting bar spring bracket, set at an angle so as to provide spring positions of different length, causes the connecting bar springs to exert greater tension on the connecting bars having greater length. The rear end of each connecting bar has a connecting link attached thereto which supports a punch selector bar on its upper end. The punch selector bars are located in the punch head directly in line with their respective punches.

When a key lever and its associated selecting bar are depressed, they carry downward, those "T" bars that are not in line with the notches in the selecting bar. Each "T" bar in motion actuates its respective connecting bar which pivots on its fulcrum and raises its connecting link and the attached punch selector bar to a point where the selector bar is positioned behind its respective punch.

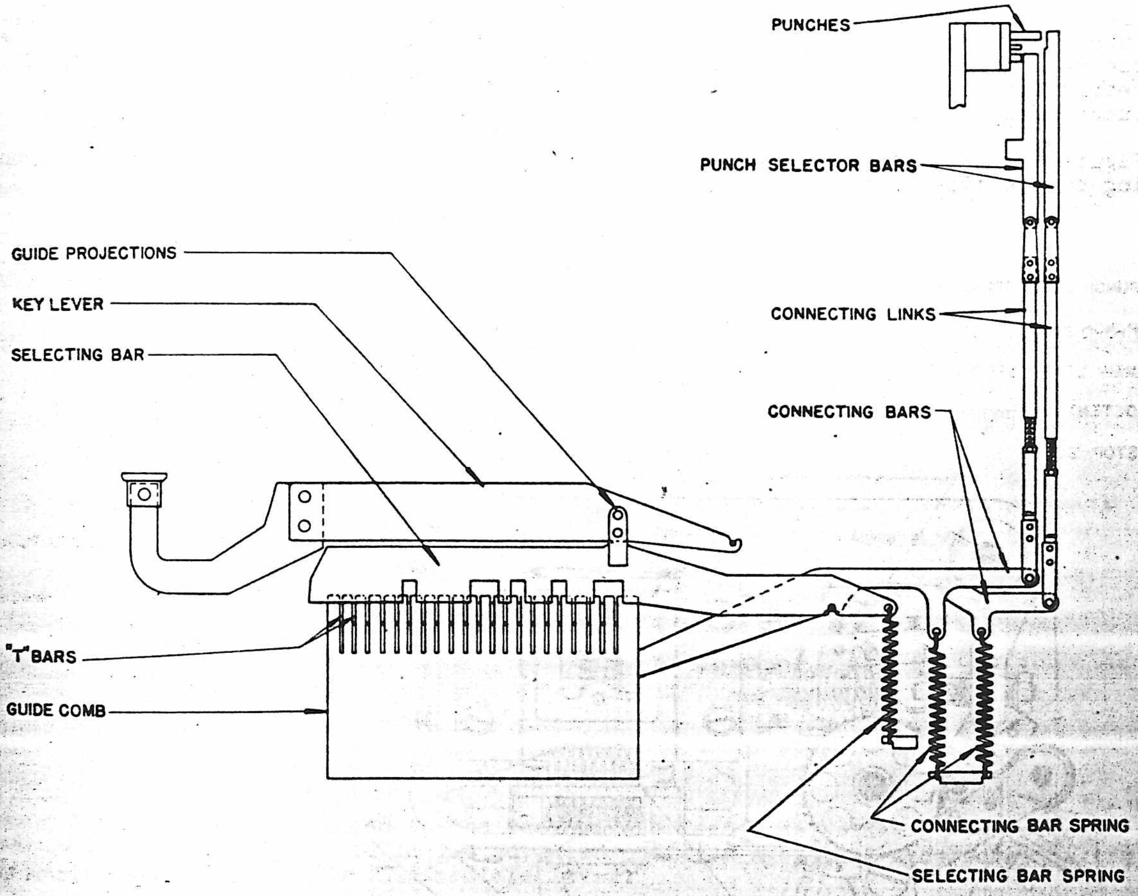


FIGURE 2

Punching Mechanism

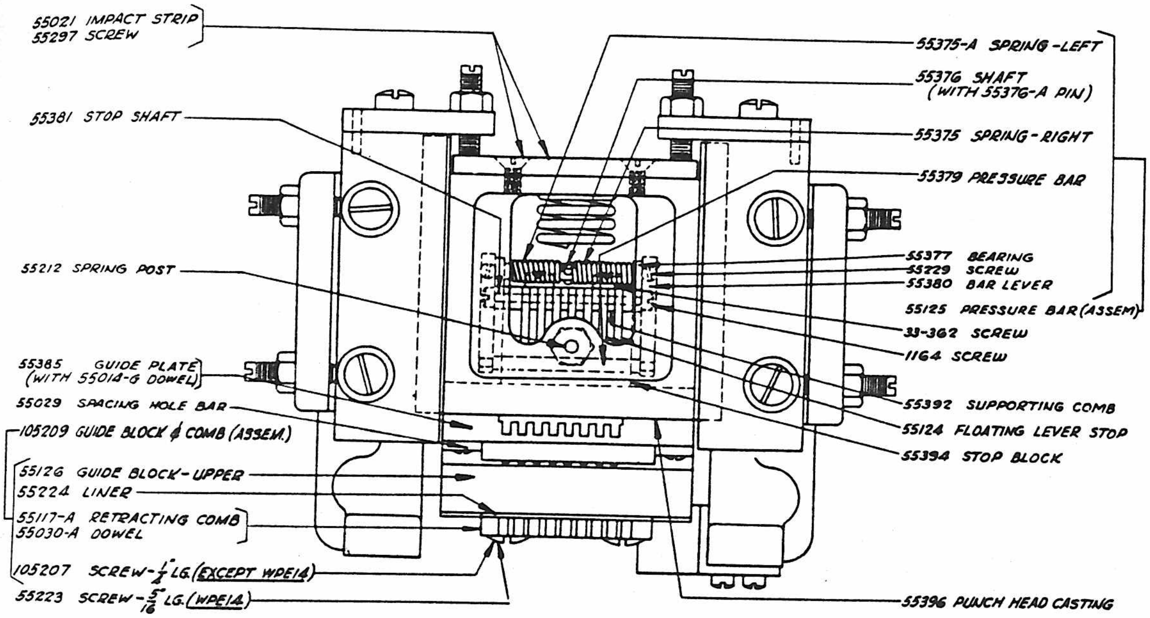
The motivating force for the punching operation is supplied by a solenoid magnet and plunger which is operated on a direct current power supply. The solenoid plunger is connected to a main lever, located on top of the perforator, through the medium of a link and bell crank (Figure 3). A valve in the lower core of the magnet regulates the passage of air and thereby cushions the downward stroke of the solenoid plunger. A sliding punch head is located directly in front of the main lever and carries a punch retracting comb on its front face. The teeth of the retracting comb occupy the spaces between the punches of the die block which is mounted directly

TELETYPE CORPORATION
CHICAGO, ILLINOIS, U.S.A.

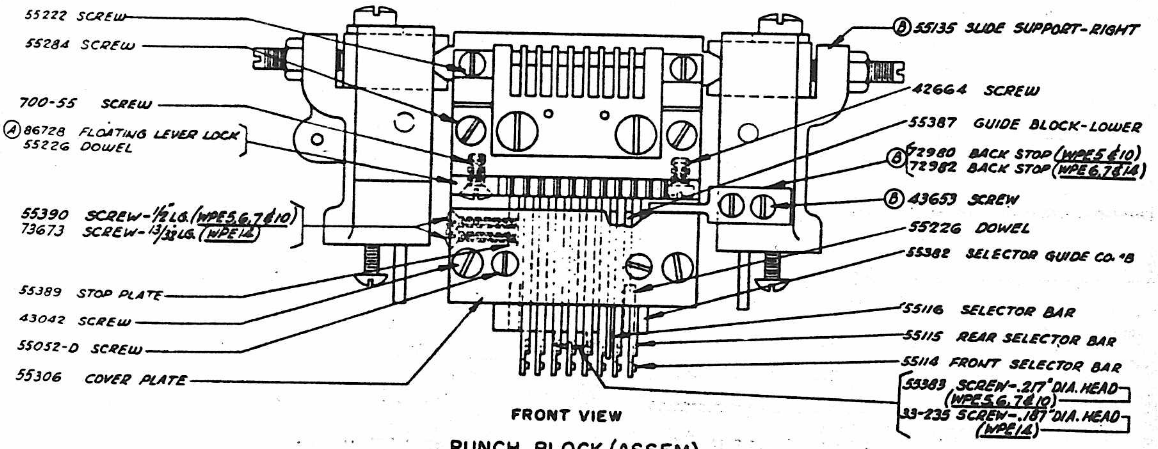
EE-503
ISSUE 1, PAGE 1
JULY, 1945

CHANGES AND ADDITIONS
BULLETIN NO. 1025 (ISSUE 3)
PARTS-TELETYPE WHEATSTONE PERFORATOR

THIS CORRECTION SHEET COVERS ORDERING INFORMATION FOR SPECIAL PARTS USED ON CABLE CODE PERFORATORS (WPE5,6,7,10 & 14).
FOR ALL OTHER PARTS REFER TO BULLETIN NO. 1025 (ISSUE 3).



TOP VIEW


55222 SCREW
55284 SCREW
700-55 SCREW
Ⓐ 86728 FLOATING LEVER LOCK
55226 DOWEL
55390 SCREW-1/2" LG. (WPE5,6,7&10)
73673 SCREW-13/32" LG. (WPE14)
55389 STOP PLATE
43042 SCREW
55052-D SCREW
55306 COVER PLATE
Ⓑ 55135 SLIDE SUPPORT-RIGHT
42664 SCREW
55387 GUIDE BLOCK-LOWER
Ⓑ 72980 BACK STOP (WPE5&10)
72982 BACK STOP (WPE6,7&14)
Ⓑ 43653 SCREW
55226 DOWEL
55382 SELECTOR GUIDE CO. #B
55116 SELECTOR BAR
55115 REAR SELECTOR BAR
55114 FRONT SELECTOR BAR
55383 SCREW-.217" DIA. HEAD (WPE5,6,7&10)
33-235 SCREW-.187" DIA. HEAD (WPE14)

FRONT VIEW

PUNCH BLOCK (ASSEM.)

WITH DIE BLOCK (ASSEM.) REMOVED
SEE PAGE 2 FOR DIE BLOCK (ASSEM.)

ⒶⒷ SEE PAGE 4 FOR NOTES OF EXPLANATION

UNLESS OTHERWISE SPECIFIED ALL PARTS SHOWN ON THIS PAGE ARE COMMON TO WPE5,6,7,10 & 14.

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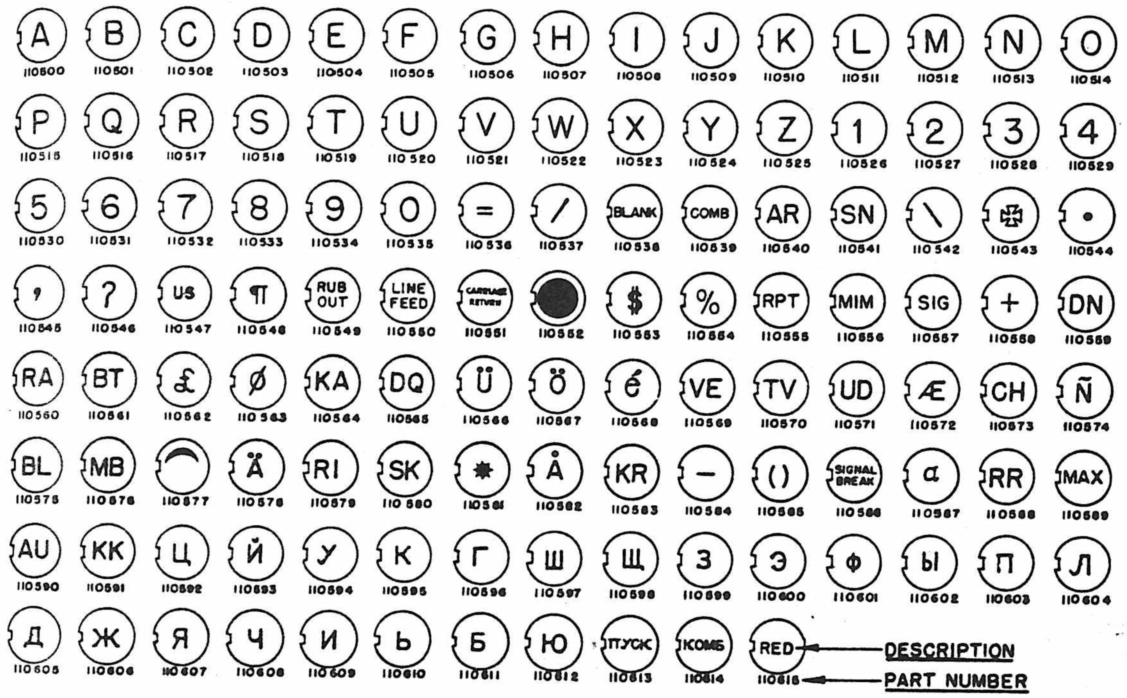
MISCELLANEOUS KEYTOPS
(CELLULOSE ACETATE)

USED ONLY WITH NEW STYLE (ONE-PIECE) KEY BARS SHOWN AT THE BOTTOM OF THIS PAGE



DESCRIPTION	PART NUMBER
A	110500
B	110501
C	110502
D	110503
E	110504
F	110505
G	110506
H	110507
I	110508
J	110509
K	110510
L	110511
M	110512
N	110513
O	110514
P	110515
Q	110516
R	110517
S	110518
T	110519
U	110520
V	110521
W	110522
X	110523
Y	110524
Z	110525
1	110526
2	110527
3	110528
4	110529
5	110530
6	110531
7	110532
8	110533
9	110534
0	110535
=	110536
/	110537
BLANK	110538
COMB	110539
AR	110540
SN	110541
\	110542
✠	110543
•	110544
,	110545
?	110546
US	110547
¶	110548
RUB OUT	110549
LINE FEED	110550
CARRIAGE RETURN	110551
●	110552
$	110553
%	110554
RPT	110555
MIM	110556
SIG	110557
+	110558
DN	110559
RA	110560
BT	110561
£	110562
Ø	110563
KA	110564
DQ	110565
Ü	110566
Ö	110567
É	110568
VE	110569
TV	110570
UD	110571
Æ	110572
CH	110573
Ñ	110574
BL	110575
MB	110576
⌒	110577
Ä	110578
RI	110579
SK	110580
✱	110581
Å	110582
KR	110583
—	110584
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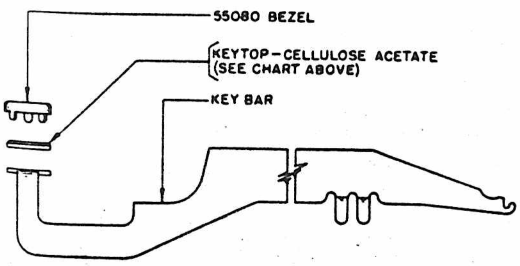
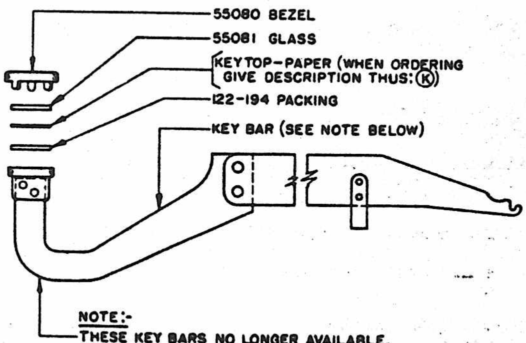
SIGNAL BREAK	110586
α	110587
RR	110588
MAX	110589
AU	110590
KK	110591
Ц	110592
Й	110593
У	110594
К	110595
Г	110596
Ш	110597
Щ	110598
З	110599
Э	110600
Ф	110601
Ы	110602
П	110603
Л	110604
Д	110605
Ж	110606
Я	110607
Ч	110608
И	110609
Ь	110610
Б	110611
Ю	110612
ПУСК	110613
КОМБ	110614
RED	110615



NEW STYLE (ONE-PIECE) KEY BAR
USED ON LATE MODELS



NOTE:-
THESE KEY BARS NO LONGER AVAILABLE. WHEN ORDERING REPLACEMENTS FOR OLD STYLE KEY BARS, ALSO DESIGNATE KEYTOP CHARACTER DESIRED.

OLD STYLE (MULTI-PIECE) KEY BAR
USED ON EARLY MODELS

Bell Sys Tech J.
v 17 (1938)

Fundamentals of Teletypewriters Used in the Bell System

By E. F. WATSON

During the past few years the use of teletypewriters has become quite extensive in the Bell System. Simpler and cheaper machines have recently been made available for meeting the simpler service requirements and attachments have been designed to provide additional features for meeting more complex service requirements. This article discusses the fundamental principles and various features of the teletypewriter machines now in common use and explains the more important factors which have been controlling in their development.

WITH the growth of Teletypewriter Exchange Service and the general increase in the use of teletypewriters in private line services of various types, questions frequently asked are: How do teletypewriters operate? What is the "start-stop" system? Why is it used? What is a regenerative repeater?

This article will attempt to answer some of these questions and explain also the fundamental principles and features of teletypewriters and their auxiliary arrangements as now employed in the Bell System. These have been developed to meet the needs of customers for a typed or similar record form of communication and at the same time be suitable for operation in connection with the Bell System plant.

CODE

For economical transmission over long distances it is fundamental that only a single wire or transmission channel be required to carry the signals. Furthermore, long experience with manual telegraphy on land lines has proved that reliable and efficient operation is secured by using not more than two conditions on the line, such as current and no current or positive impulses and negative impulses, as contrasted with the use of three or more conditions, or current values. The entire telegraph plant of the Bell System as well as practically all other land line telegraph systems have been built on this two-condition basis.

The familiar Morse code uses sequences of dots and dashes to represent the different characters of the alphabet and meet the above conditions. This code is not well adapted for teletypewriter control, however, since the signals for different characters vary widely in the time they require, from a single dot for the letter E to a combination of several dots and dashes for some of the less frequently used letters or numerals.

For machine operation it has thus far appeared desirable in order to obtain simplest mechanisms and to obtain maximum operating speeds with low line signaling frequencies, to have the signals for the different characters of uniform length, that is, each contain the same number of time units. This condition is met by the five-unit code where each character is identified by the impulses in five units of time, and this is the code normally employed in Bell System teletypewriters. Each of the five units of this code may be either positive or negative, current or no current, or either of two values of current, and the permutations provided are 2^5 or 32. These are sufficient for the 26 letters of the alphabet, a space, carriage return and paper feed signals as well as case shifting signals to bring another set of characters into action so as to include numerals and punctuation marks. A chart of this code as used in Teletypewriter Exchange Service (TWX), is shown below.

FIGURES	—	5/8	1/8	$	3	1/4	&	STOP	8	,	1/2	3/4	.	7/8	9	0	1	4	BELL	5	7	3/8	2	/	6	"	LINE FEED	SPACE	CAR. RET.	LETTERS	FIGURES	BLANK
LETTERS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z						
PULSE 1	●	●		●	●	●				●	●						●		●		●		●	●	●	●				●	●	
PULSE 2	●		●				●		●	●	●	●				●	●	●			●	●	●				●			●	●	
PULSE 3			●			●		●	●		●		●	●		●	●		●		●	●		●	●			●		●		
PULSE 4		●	●	●		●	●			●	●		●	●	●			●				●		●					●	●	●	
PULSE 5		●					●	●				●	●		●	●	●			●		●	●	●	●	●				●	●	

Fig. 1—Chart of five-unit TWX code.

The keyboard used for sending this code is shown below.

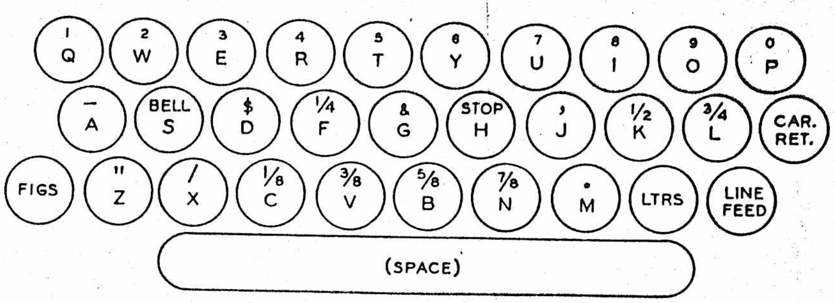


Fig. 2—Chart of TWX keyboard.

It will be noted that this keyboard is similar to the ordinary typewriter keyboard except that there are only three rows of keys instead of four as in the typewriter. In the typewriter keyboard, the lower three rows of keys are used ordinarily for small letters but when a shift key is also operated they type the corresponding capital letters. The fourth or top row of keys carries the numerals and certain punctuation marks. The teletypewriter types capital letters but not small letters so that by using a shift or *Figures* key the upper case position of the letter keys is available for the usual punctuation marks and numerals. Thus only three rows of keys are required on the teletypewriter keyboard. The operation of the *Figures* key sends a signal causing the receiving machine to shift to upper case so that numerals and punctuation marks will be printed until a *Letters* or *Space* signal is sent which restores the machine to lower case.

START-STOP SYSTEM

For transmitting the signals of the five-unit code over a telegraph line, it is necessary to have some system of timing so that each of the five impulses may be properly received, identified and interpreted at each receiving station. The start-stop system is used for this purpose. One arrangement of this system using segmented distributors with revolving brushes, is illustrated in Fig. 3.

In this system both sending and receiving brush arms are normally at rest but are maintained under constant torque, tending to rotate them in the direction of the arrows, by constantly running motors driving them through friction clutches. Normally the line circuit is closed and carries current. When a key of the keyboard is operated to send a signal, the start magnet of the sending distributor is energised releasing the sending brush arm and allowing it to rotate. As this brush passes from the stop to the start segment, the line circuit is opened and this open signal transmitted to the receiving station where it causes energization of a start magnet which releases the receiving brush and allows it to rotate.

Both sending and receiving brush arms rotate at approximately the same speeds since they are driven from motors running at approximately the same speeds. These motors are either small synchronous motors driven from constant frequency commercial 60-cycle 110-volt power supply or by commutator type motors, equipped with centrifugal governors to hold them at approximately a constant speed, for use on other commercial a-c. or d-c. supplies.

Now as the sending brush arm sweeps over the sending face, the impulses of the five-unit code, as set up by the particular key depressed, will be transmitted over the line as shown in Fig. 4 for the letter A, and through the action of the rotating receiving brush, Nos. 1 and 2 current impulses will cause the energization of Nos. 1 and 2 selecting

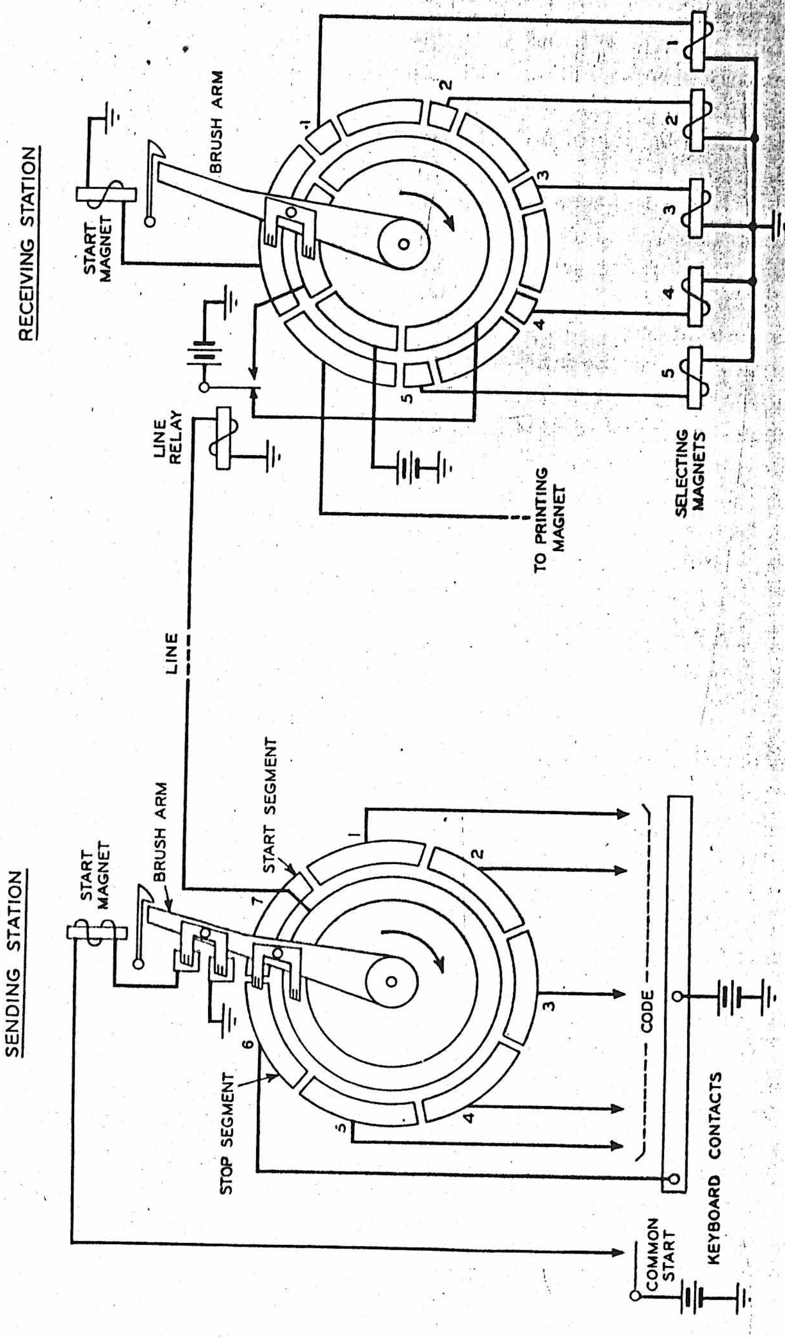


Fig. 3—Simplified diagram of start-stop system.

magnets while Nos. 3, 4 and 5 no-current impulses will not energize selecting magnets 3, 4 and 5.

Similarly other signals for other characters may be sent and received as permutations on the selecting magnets whose operation may in turn control the selection of an individual type bar to be operated to type the desired character.

While brush and segment distributors are shown above for purposes of illustration, in modern machines these are replaced by simple mechanical devices, sending contacts and a single receiving magnet, which function in the same manner but are cheaper, more reliable and easier to maintain.

Advantages of the start-stop system over other systems of timing include its simplicity, the fact that highly accurate speed regulation of the motors is not required, that to start a station it is only necessary to turn on the power, and that lag in the line signals due to time for propagation is automatically compensated for. The lag compensation is automatic because the receiving distributor does not start until the start signal has been propagated and received and then the other signals always follow in a fixed definite time relation. This makes it possible to connect any number of stations to a single circuit and have them intercommunicating; that is, signals sent from any station will be received and printed at all other stations without requiring readjustments, regardless of the distances or circuit complications due to repeaters and the like intervening.

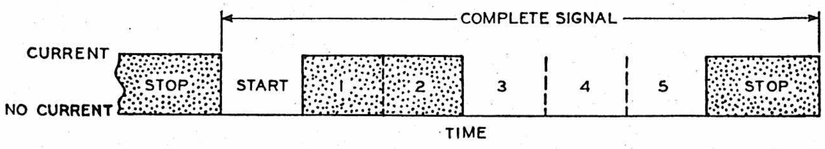


Fig. 4—Chart of line signal for letter A.

To illustrate one of these points further, it may be mentioned that with the start-stop system, if other distortions were not present, it would be theoretically possible to secure perfect operation without errors between two ideal distributors one of which was running either faster or slower than the other by as much as 7 or 8 per cent. This is because a correction is automatically made after each character is transmitted. Since some distortion of the signals is usually experienced in transmission, in order to maintain a large tolerance for such distortions, it is the usual practice to attempt to maintain the speed of each distributor within ± .75 per cent although a much larger variation may be tolerated without causing errors except when it occurs simultaneously with an abnormally large line distortion.

In contrast with this, in a synchronous system such as employed in the usual "Multiplex Printer System," it is necessary that the speeds of distributors be very accurately maintained or errors in transmission will result. This is accomplished by controlling the driving motors from very accurate timing sources such as tuning forks, then testing the speed of the receiving distributor two or more times every revolution from the signals transmitted over the line from the sending distributor, and automatically correcting this speed as required. If it were not for this last mentioned correction in order to receive signals correctly on a two-channel multiplex system for a period of 15 minutes at a speed of 60 words per minute per channel, the receiving distributor speed would have to be held accurate within ± .002 per cent. In other words, in 15 minutes the receiving distributor would make about 5400 revolutions (60 words per minute × 6 revolutions per word × 15 minutes). At the end of the 15 minutes, if it were one-tenth of a revolution ahead or behind its correct position, a No. 3 pulse, for example, would be received on a No. 4 or No. 2 segment resulting in an error. Thus the limit would be that the receiving distributor could not run fast or slow by as much as one-tenth revolution in 5400 revolutions or roughly 2 parts in 100,000.

Tolerance for Distorted Line Signals

During transmission over long lines, telegraph signals may become badly distorted; that is, the dots and dashes may be considerably shortened or lengthened from their correct values. It is essential that the receiving distributors be capable of receiving and interpreting these signals without error. To accomplish this the receiving distributors are arranged so that they are sensitive for the reception of the selecting impulses only for a very short time at the middle of each impulse. The exact location of this sensitive period with relation to the incoming signals is adjustable in each receiving distributor so that it may have maximum tolerance for receiving distorted signals. This situation is illustrated in the diagram, Fig. 5, which shows a receiving distributor with the received signals under various conditions developed, and the sensitive points for the reception of the impulses indicated by small arrows.

It will be noted from this chart that the signals may be very badly distorted (theoretically up to nearly 50 per cent of a pulse length at either the front or rear end of a current pulse), without causing imperfect reception.

In the figure it will be noted that trace (a) shows a perfect signal with the arrows denoting the sensitive points for receiving each pulse located directly at the center of each of the pulses 1 to 5. This is a normal adjustment for a receiving distributor which, without change of this adjustment, must be able to tolerate the distortions of various kinds experienced in service without failure to receive and properly identify each pulse as a No. 1, 2, 3, 4 or 5 pulse. The other traces illustrate certain types of distortions which may be experienced and the conditions existing for their proper reception with this adjustment. These traces will now be explained on a purely theoretical basis assuming an ideal receiving machine without mechanical or other imperfections.

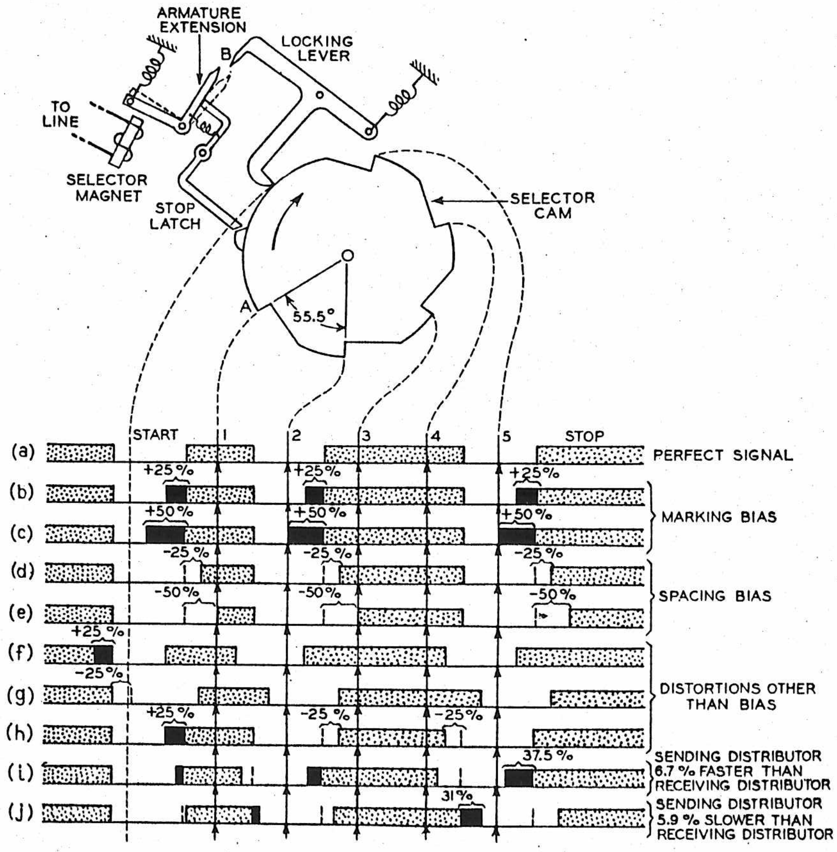


Fig. 5—Effect of distorted signals on reception.

Trace (b) shows the conditions in case of 25 per cent "marking bias" in the received signals; that is, each marking pulse has been lengthened by 25 per cent of one pulse length. It will be noted that under these conditions each pulse will still be properly received and identified.

Trace (c) illustrates 50 per cent marking bias in the received signal, and at this point it will be noted that the No. 3 and stop pulses have been so elongated that they are just on the verge of being erroneously received and identified also as No. 2 and No. 5 pulses. This then is a theoretical limit for proper operation with marking bias without a readjustment of the receiving distributor.

Similarly traces (d) and (e) illustrate respectively the conditions when the received signals have 25 per cent and 50 per cent "spacing bias," that is each marking impulse has been shortened by this percentage of one pulse length. It will be noted that 25 per cent spacing bias can be easily tolerated but that with 50 per cent spacing bias the No. 1 and No. 3 pulses are on the verge of failure to be recorded. This then is a theoretical limit for spacing bias in the signals under this adjustment.

Traces (f) and (g) show the effect of 25 per cent marking and spacing distortions respectively on the rear end of the stop or front end of the start impulse, all other pulses remaining undistorted.

Trace (h) shows the effect of distortions on the selecting impulses alone. By combining this trace with traces (f) and (g) it will be seen that with 25 per cent distortion of the start pulse, 25 per cent distortion of the same sign is the limit for distortion on the front end of marking impulses, or 25 per cent distortion of opposite sign on the rear end of marking impulses. Thus for distortions other than bias, which are apt to affect both start and selecting impulses in the same signal, ± 25 per cent is the theoretical limit of allowable distortion.

Traces (i) and (j) show the effects of speed inaccuracies. From these it will be seen that theoretically the sending distributor could be about 8.9 per cent faster or 9.5 per cent slower than the receiving distributor before errors would be experienced.

In practical machines there are, of course, inaccuracies due to tolerances of manufacture, and other departures from the ideal so that the above mentioned theoretical limits are not reached. However, all machines used in the Bell System are required to tolerate a lengthening or shortening of the front end of any current impulse of at least 40 per cent of its length and with the same adjustment a lengthening or shortening of the rear portion of any current impulse of at least 35 per cent with the start pulse undistorted. Since bias is nearly always present to some degree in the received signals, and since as interpreted by the receiving distributor it affects only the front end of the current impulses as illustrated in traces (b), (c), (d) and (e) of Fig. 5, the distributors are usually adjusted for maximum tolerance of front end distortions and then have ample tolerance for such distortions of the rear ends of the current impulses as are experienced under service conditions.

REGENERATIVE REPEATERS

As circuits become longer and more complex, eventually a point is reached beyond which signal distortion becomes so great that the signals cannot be reliably received without error. To overcome this limitation a device known as a regenerative repeater may be inserted in the line at this point. It has a receiving mechanism similar in principle to the receiving distributor of a teletypewriter and will accurately receive and interpret any signals which a teletypewriter would accurately record. This receiving mechanism is interconnected with a retransmitting mechanism, or sending distributor, which retransmits the signals reshaped and reformed so as to be substantially free from distortion. In its latest form a one-way regenerative repeater consists of a receiving magnet and a set of transmitting contacts interconnected by some relatively simple mechanical parts driven from a motor. A photograph of such a recently developed regenerative repeater unit is reproduced in Fig. 6.

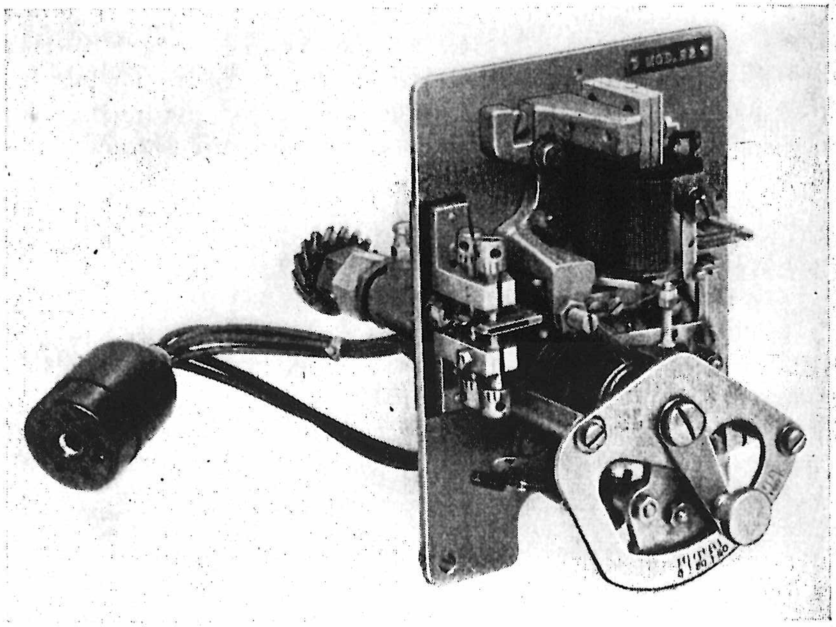


Fig. 6—Regenerator unit.

By means of these regenerative repeaters reliable teletypewriter service may be extended to any desired distances so long as the signals in any one regenerative repeater section are not too badly distorted to permit reliable operation of that section alone. Several regenerative repeaters may be operated in tandem on a single very long circuit if required and in fact a number of very difficult long circuits are operating satisfactorily under these conditions at the present time. A point worthy of note and which has not previously been mentioned is that the stop impulse in the code adopted for Bell System apparatus is slightly longer than the other impulses, which facilitates the use of regenerative repeaters in tandem without requiring complex speed control arrangements.

GENERAL FEATURES OF TELETYPEWRITERS

Teletypewriters are widely used for high speed written communications. Generally speaking, written communications are desired for purposes of accuracy. Therefore, high speed, accuracy and reliability are basic requirements for teletypewriter service.

In choosing an operating speed at which distributors of teletypewriters are to be set, several factors must be considered. These are the capabilities of the mechanisms of the machines, the average capabilities of operators for continuous sending at high speeds, the commercial need for high speeds, and the capabilities of the line circuits for transmitting the signals reliably over long periods without excessive distortions or excessive attention for maintenance and adjustment. A satisfactory compromise among these different factors seems at the present time to be about 60 words per minute, or 368 machine operations per minute, which is the speed usually employed in the Bell System. The machines themselves may be arranged and adjusted to be capable of higher speeds up to about 75 words per minute, and it may be that, in the future, service at these higher speeds will be justified under certain circumstances.

Accuracy and freedom from breakdown troubles are necessarily inter-related and both required to a very high degree for machines handling important written communications over long distances. To give some idea of the severity of these requirements, we have found from long experience that to produce a good machine we can not be satisfied in our laboratory tests unless the machine is capable of typing at least 1,000,000 consecutive words (6,000,000 operations) without error or trouble of any kind, and without requiring service attention of any kind other than normal replacement of paper and inking ribbons.

For rendering service economically with teletypewriters on subscribers' premises, an important requirement in order that the expense of maintenance be not prohibitive is that the machine should not require maintenance attention except at very infrequent intervals. Bell System machines are designed to require routine maintenance attention not oftener than once in two months where the machine is used continuously over periods of eight hours each day. To accomplish this the problem of lubrication has required very careful attention. It has necessitated the provision of oil reservoirs in certain places and the careful selection and specification of oils and greases. Another feature making for economical maintenance is interchangeable parts. In other words, if a part breaks or wears, it is replaceable by another part of the same type without requiring fitting and usually without readjustment.

At times customers wish to use teletypewriters on tables especially designed and arranged to suit the convenience of their offices. For this reason teletypewriters are designed as far as feasible to be self-contained units which can be mounted on any desk or table.

All present Bell System teletypewriters employ the start-stop system of synchronizing and are well adapted for the connection of any number of machines to one circuit with facilities for rapid to and fro intercommunication among the various stations. To permit optimum control of intercommunication and interruption of the sending station when desired, a device known as the "break lock" is incorporated in many machines. This device, together with a "break" key located on each machine, provides facilities whereby any station may interrupt a station which is sending, take control of the circuit and send. The operation of the "break" key opens the line transmitting a signal which causes the "break lock" device to function at the station which is sending and automatically stop any further sending from that station until the device is manually restored. This device is very important in the case of transmission from a perforated tape, which is described later.

Motor control devices are of importance for stations which are not in continuous use but which may wish to receive messages from time to time from distant stations without requiring an attendant to turn on the machine. Such devices are used both in private line and in TWX services. In the case of a private line it is often desired to have the machine normally idle with the motor stopped but so arranged that, when a distant station wishes to send a message, a signal may be sent which will automatically start the motor and condition the receiving machine so that it will properly record the message and then have its motor automatically stopped again at the end of the communication. Various devices are available for this purpose, some operating over the regular signaling circuit and others requiring a separate circuit. Similarly, in the case of TWX service, stations may, if desired, be equipped for unattended service so that, if the station is called and no attendant is present, the teletypewriter motor may be started remotely by the switchboard operator and the station conditioned to record the incoming message at the termination of which the motor can again be stopped by the switchboard operator.

Signal bells are usually provided on the machines so that, if it is desired to call an attendant to a working machine or to call attention to a specially important message being received, the bell can be rung by signals sent over the circuit.

A general feature incorporated in the design of all modern machines, and one which is not often appreciated, is the so-called "overlap." This feature makes high speed possible by overlapping the selecting and printing parts of the receiving operation. In other words it provides for the typing of one character to take place simultaneously with the reception of the selecting impulses for the next character.

Features of Page Teletypewriters

Page teletypewriters have been built in several different forms, notably with a moving paper carriage or a stationary paper carriage and with a typewheel or with type bars for printing. An early design employed a moving paper carriage and a typewheel, with an ink roller for inking the characters on the wheel. With this design it was impractical to make satisfactory carbon copies, the printed record was unevenly inked, and much trouble was experienced due to side printing, that is, unwanted printing of portions of letters adjacent to the desired letter on the typewheel. Furthermore, considerable trouble was had in properly feeding paper from a paper roll through the moving paper carriage.

To eliminate these limitations and troubles it was decided that for general service in the Bell System a new machine should be designed to be capable of making as many carbon copies as a typewriter and that it should use type bars and have a stationary paper carriage. This sort of machine was new in the art and required extensive development work to produce a satisfactory commercial design because of the inherent difficulties of moving an automatically operated basket of typebars back and forth in front of the stationary paper. The present standard No. 15 teletypewriter was the ultimate result of this work and has proved very satisfactory in general service over a number of years. It employs a typewriter ribbon for inking, has the paper roll inside the machine cover and makes very satisfactory carbon copies with various types of paper supply without being subject to the paper feed, inking and side print troubles previously experienced.

This machine has also lent itself to meeting later demands from business houses for typing either single or duplicate copies on special printed forms as commonly used in modern business practice. By equipping the platen with sprocket teeth and having feeding perforations along the edges of the forms, all copies of these forms are automatically held in perfect registration during typing at all stations connected to the circuit. In connection with the rapid handling of these forms a further requirement for automatic tabulation has been met by providing a tabulating device which on the transmission of a certain signal causes all carriages to move over rapidly to any predetermined position on the form and stop there for the typing of letters or figures in columns perfectly aligned. This device greatly facilitates the rapid transmission and reproduction of orders and the like on organized printed forms.

With the advent of TWX service a new situation arose in which many of the machines were only infrequently used and then for very short periods to make a single copy only. To render this service economically it seemed desirable to have a less expensive machine and since narrower capabilities were required this seemed entirely feasible. Accordingly a new machine known as the No. 26 teletypewriter has been developed primarily to print a single satisfactory copy although one carbon copy can be made if desired. To obtain low first cost this machine has a moving paper carriage and to secure a satisfactory printed record it employs ribbon inking and a typewheel arrangement which is a sort of cross between conventional typebar and typewheel designs. This typewheel is an assembly employing a small individual type pallet for each separate character. In the process of printing a character, a striking arm somewhat like the shank of a typebar comes forward and forces the individual type pallet against the ribbon to make an impression on the paper. The typewheel is rotated to different positions to select the different characters to be typed. In this way satisfactory inking and a clear cut impression without side print is obtained, which compares favorably with the record obtained

on a typebar machine or typewriter. The entire machine costs appreciably less than the more comprehensive No. 15 machine. The No. 26 machine is illustrated in Fig. 7.

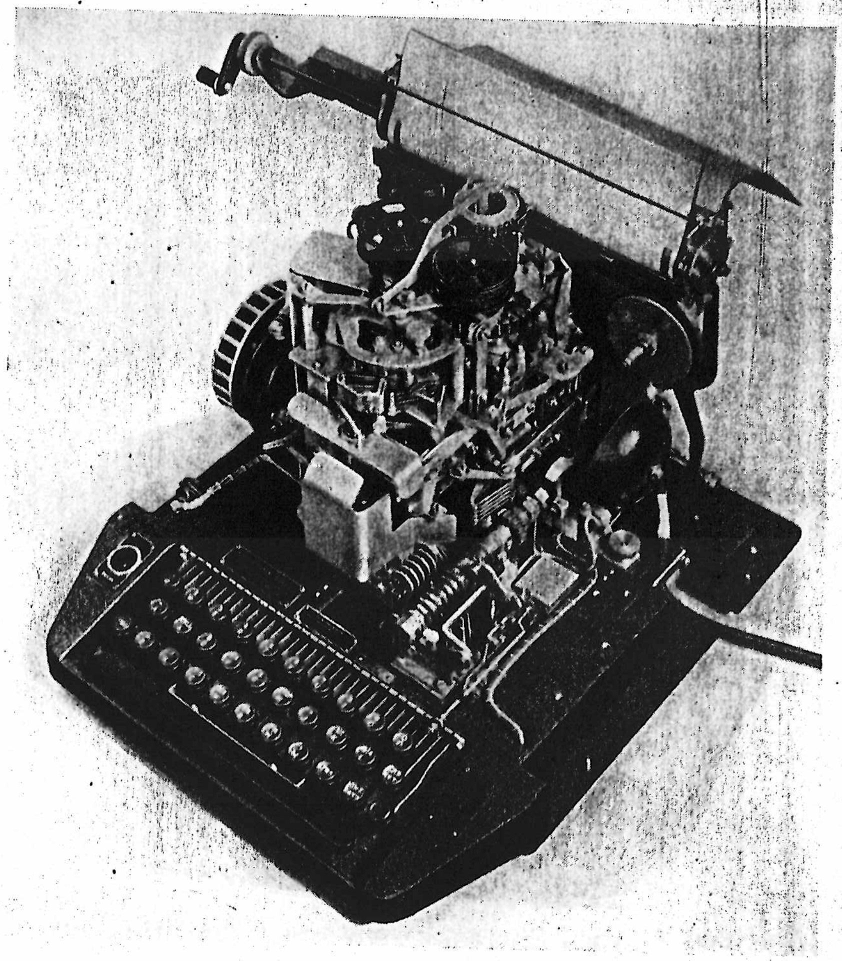


Fig. 7—No. 26 teletypewriter.

Features of Tape Teletypewriters

In the case of tape teletypewriters it is also necessary to have a clean printed record and occasionally there is a need for carbon copies. Accordingly, the tape machine standard for the Bell System is a typebar machine using an inking ribbon and known as the No. 14 teletypewriter. It is illustrated in Fig. 8.

A feature worthy of note is that with this machine typing always occurs at the same point introducing a problem in connection with platen wear. If the platen were fed by the usual ratchet in, say, 36 steps per revolution, there would be heavy wear concentrated at these 36 points and the platen would require frequent replacement to preserve good printing. To avoid this, the platen is fed through differential gearing so that on a second revolution the typing comes in a different spot from that of the first revolution; thus the wear is uniformly distributed over the entire circumference.

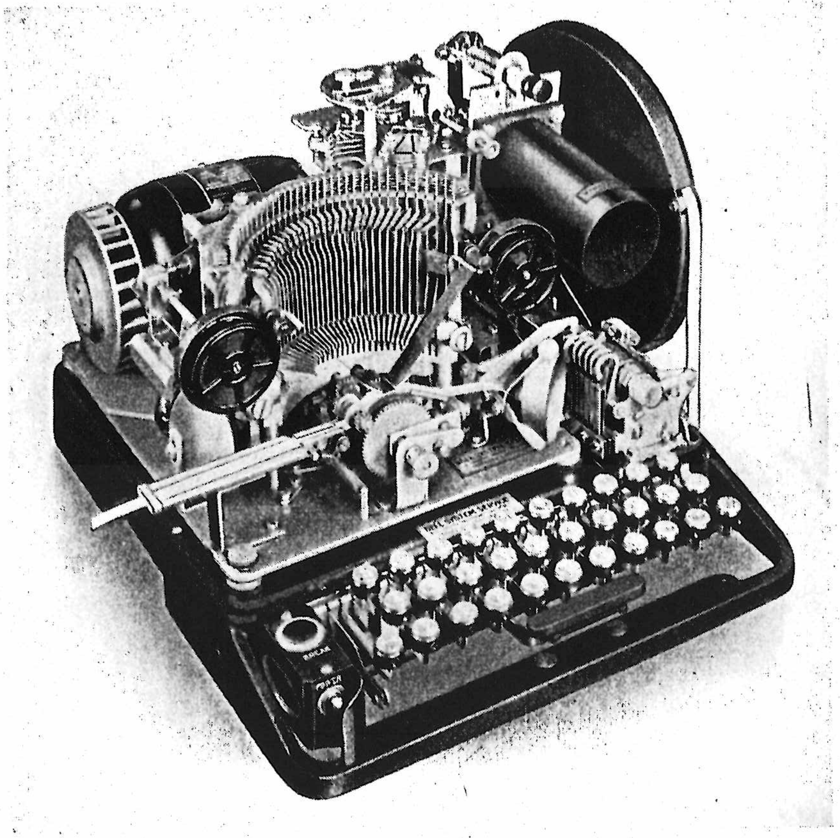


Fig. 8—No. 14 teletypewriter.

One carbon copy can be made by leading tapes through the machine from two rolls of record paper and one roll of carbon paper. Two carbon copies can be made in a similar way if desired.

The tapes employed may be either gummed on the back for convenient pasting on blanks for filing or may be plain paper tapes if the records are of temporary interest only. Also cellophane or similar transparent tape may be used if it is desired to project the record on a screen. A tape out signal is provided on the machine so that when a roll of tape becomes nearly exhausted a bell will ring continuously to give warning of this fact. Where a bell is not desired, the last few feet of tape on the roll are painted red to give similar warning.

If desired, this tape printing machine may be used on the same circuit with page printing machines such as the No. 15 teletypewriter, and when so employed is usually equipped with an "end of line indicator" to warn the operator of the approach of the end of the line in the page machine, so that suitable signals may be sent for starting a new line.

FEATURES OF TWX SWITCHBOARD OPERATORS' TELETYPEWRITERS

Such machines must be small in size to permit their use in a switchboard position, quiet in operation to permit their use in the same room with a telephone switchboard and must be capable of working with any machine employed in the TWX system.

To meet these requirements the standard No. 14 tape teletypewriter has been modified in several important respects as follows:

1. It has been provided with a specially designed enclosing cover which reduces the machine noise radiated by at least 5 db more than standard covers.
2. The machine is tilted so as to raise the keyboard and permit the operator to assume a more elevated position nearer the switchboard jack field.
3. It is equippent with an end of line indicator mechanism and lamp to warn of the approach of the end of a line when sending to a page teletypewriter station so that the proper signals may be sent to start a new line.
4. The usual tape feeding mechanism which pulls the tape past the typing point and obscures some of the typed message is replaced by a so-called "push feed" mechanism which acts ahead of the typing point and makes the typed message more fully visible.
5. Many of the operators' machines are provided with specially arranged power supply and governing circuits so that their motors normally run from 115 volt a-c. commercial supply but in case of a power failure can be quickly switched to run from the 130 volt d-c. telegraph battery.

Features of Monitoring Teletypewriters

In connection with private wire teletypewriter service it has been found very desirable to have so-called monitoring teletypewriters in the repeater offices to facilitate testing between offices and with the subscriber stations. These machines must be adaptable to work with any subscriber's machine and to be usable for making test measurements on circuits.

The No. 14 tape teletypewriter has also been adapted to this service. It may be equipped with an end of line indicator to facilitate communication with a page teletypewriter. Also since commercial service is given at speeds of 40 and 60 words per minute, many of the monitoring machines are equipped with two-speed governors and a switch to provide for changing from one speed to the other. These machines are also usually arranged for normal operation from commercial power supply but emergency operation from the 130-volt telegraph battery.

For making test measurements over circuits a special orientation scale is provided together with a small crank extending through the cover for quickly shifting the orientation setting to any desired point. With the machine carefully adjusted to be practically free of harmful distorting effects on the signals, it may then be used for measuring distortions in received teletypewriter signals, the scale being arranged to read the total distortion directly in percent of a pulse length.

Tape Storage Transmission

A heavy volume of traffic may be transmitted rapidly and conveniently by the use of perforated tape. In this method a machine known as a perforator and having a keyboard like that of the teletypewriter is used for punching the code signals for the message in a strip of paper tape. This may be done with simultaneous typing of the message on the teletypewriter in which case the speed of perforating is limited to the speed for which the teletypewriter is set. If a typed record is not made simultaneously with the perforating, punched tape may be prepared at practically any speed within the capabilities of the operator. This punched tape may then be fed through a device known as a tape transmitter which automatically transmits the message signals from the tape at the maximum speed for which the teletypewriters connected to the circuit are set, which is usually 60 words per minute.

The method of transmitting from perforated tape has the distinct advantage of using the line at maximum efficiency at all times as compared with direct keyboard sending where pauses in operating the keys and interruptions to the operator result in direct losses of circuit time and effectively slower transmission.

Another important advantage of the perforated tape method is that errors may be corrected in the tape before transmission with the result that only errorless copy is transmitted on the circuit. This is done in the following manner and is illustrated in the section of perforated tape shown below. If the operator in attempting to write the word THE should strike the keys T and J (in error), realizing her error she back spaces the tape one division, strikes the "letters" key and then the correct keys H and E. The transmission of the "letters" signal will cause no operation in the recording teletypewriters since they are already in the "letters" case, and the word will be recorded correctly as though no error had been made. Similarly, entire words or groups of characters may be erased from the tape if desired.

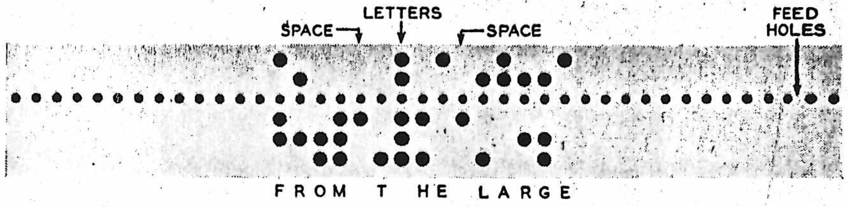


Fig. 9—Sample of strip of perforated tape.

For TWX service a further advantage of the perforated tape method is that the entire message may be punched in tape and checked by printing, if desired, before a call is placed and a connection established. Then, when the connection is established, the message can be automatically transmitted at maximum speed requiring a minimum time for the connection and giving a minimum charge for the call.

It is true, of course, that in this method there is some delay between perforation and transmission. For this reason short to and fro messages, as required in setting up a connection, may be better handled by direct keyboard. To facilitate such working, the perforator keyboard is normally arranged so that by throwing a switch this same keyboard may be used for direct keyboard sending without perforating. This switch also has an intermediate position in which the keyboard is connected for simultaneous direct sending and perforating. This provides for meeting the needs of certain TWX subscribers who wish to simultaneously type and punch the message so that the typed copy may be checked as it is perforated.

The complete page printing set arranged for tape transmission is known as the No. 19 teletypewriter set and is illustrated in Fig. 10. It employs a No. 15 teletypewriter as the page printing unit.

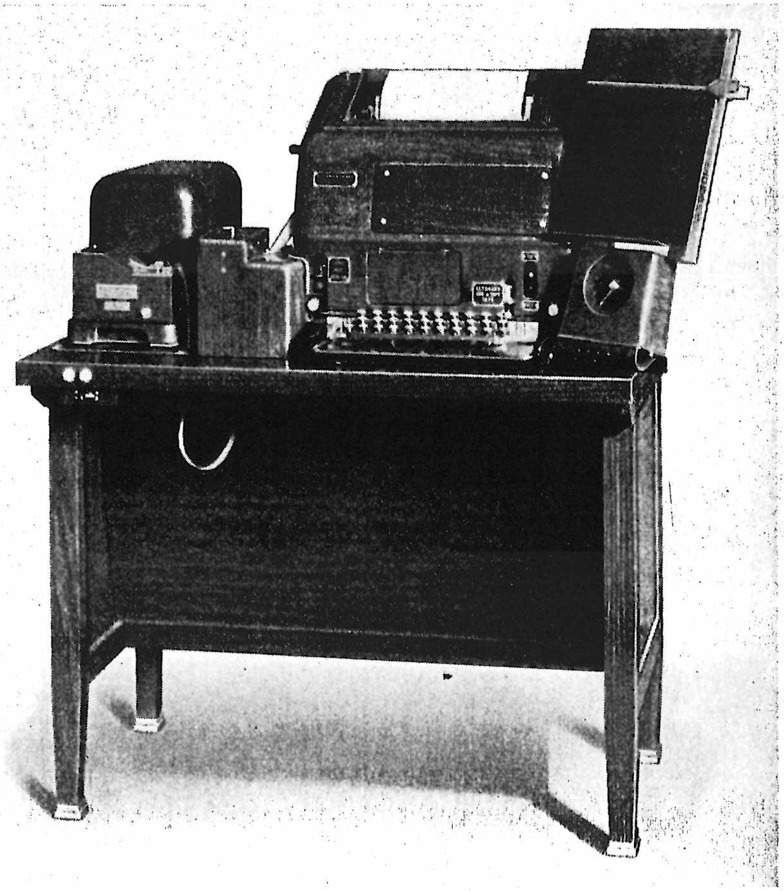


Fig. 10—No. 19 teletypewriter set.

Automatic Retransmission Using Reperforators

At times it is desirable to retransmit messages received from one circuit to some other machine or machines on a separate circuit. A unit known as a "reperforator" is often used to facilitate such retransmission. The reperforator now standard for the Bell System is a start-stop receiving device using the 5-unit permutation code. It is somewhat similar to the receiving-only tape teletypewriter except that the record produced consists of code perforations in a tape rather than typing on a tape. This perforated tape is the same as tape produced by a keyboard perforator as previously described, and may be used in an automatic transmitter for retransmitting the message on a separate circuit. The reperforator is usually associated with a receiving teletypewriter on a circuit and may be cut in or out manually or automatically from signals transmitted along with the message signals, so that it will automatically reproduce a code tape for use in automatically retransmitting such messages as desired on some new connection.

Conclusion

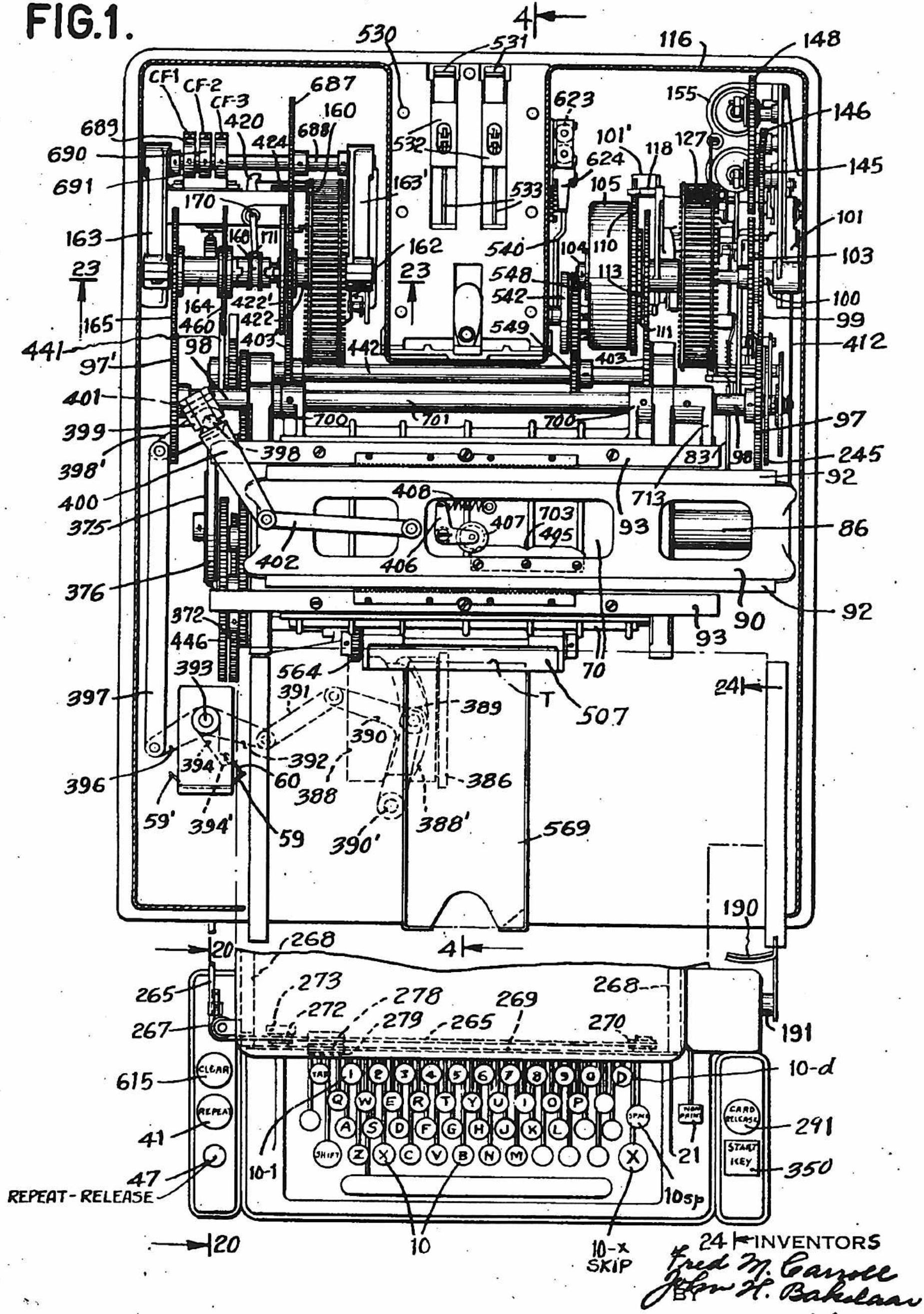
The fundamentals of teletypewriters, as described above, now seem to be fairly well established. The future should bring simpler and cheaper machines, especially where the more difficult requirements do not have to be met, and probably additional attachments and auxiliary features to extend the applications and convenience of operation.

Oct. 4, 1938. F. M. CARROLL ET AL 2,131,914

TYPEWRITER PUNCH

Filed May 16, 1936 31 Sheets-Sheet 1

FIG. 1.



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TYPEWRITER PUNCH

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FIG. 32

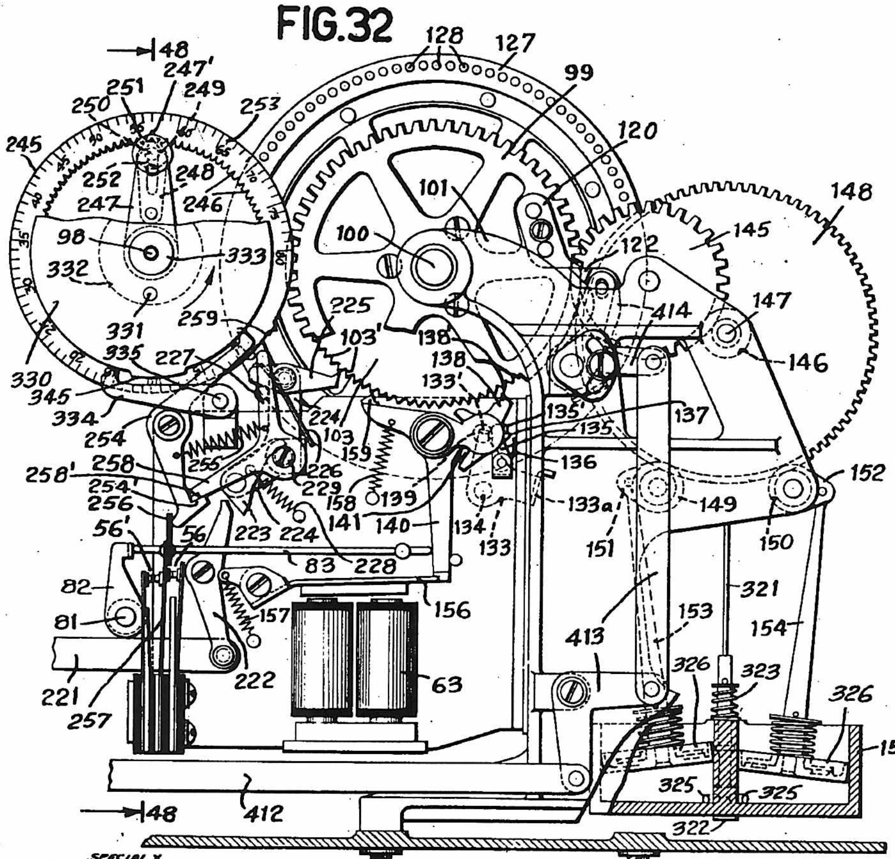
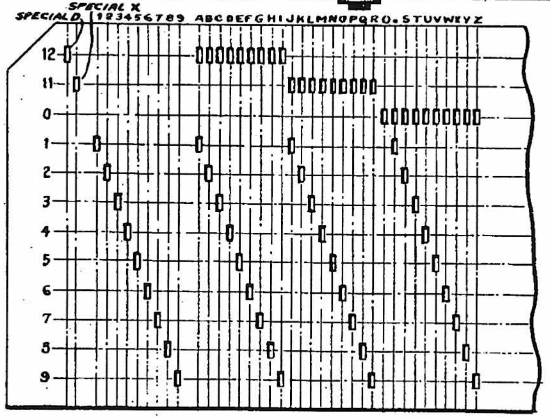


FIG. 33.



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Patented Oct. 4, 1938 **2,131,914**

UNITED STATES PATENT OFFICE

2,131,914

TYPEWRITER PUNCH

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Application May 16, 1936, Serial No. 80,044

124 Claims. (Cl. 164—113)

This case relates to recording machines, particularly to a combination typewriter and punch.

An object of the invention is to provide improved means for controlling a punching mechanism by the operation of a printing or typing mechanism.

The above object contemplates the operation of typewriter keys to effect typing of characters and simultaneous momentary formation of circuits to control punching means to punch record cards with perforations representing such characters.

Further the above object contemplates the selection by the typewriter of those fields of the typed matter to be perforated by the punching machine.

More specifically, the latter object is to control, in accordance with the movement of the typewriter carriage, certain vertical columns of the typed matter to be simultaneously selected for punching.

Still more specifically, this latter object is to provide live fields of the typewriter carriage range of travel in which the punching selection is rendered effective.

Another object is to provide means for operating the typewriter keys to effect punch control and selection without corresponding typing.

Still another object is to provide an indicator on the typewriter for indicating to the operator the progress of the punching selection.

The latter object further provides for indicating to the operator which of the card columns of a record card have been selected to be punched and the order in which different data is to be typed in order to properly select the punches for successive card columns.

A further object is to control punching means to effect repeat punching with but a single punch selecting operation.

Still another object is to control a single set of punch elements by a plurality of punch selecting mechanisms, operable one at a time.

The above object is, more specifically, to control a single set of punch elements alternately by a pair of punch selecting mechanisms.

Further, the above object contemplates the setting up of one punch selecting mechanism according to the data to be punched, while the other punch selecting mechanism is cooperating with the punch elements to punch a record card with previously selected data.

Still further, the above object provides for alternately shifting a pair of punch selecting mechanisms to punch operating and data selecting positions and to prevent such shifting before a punch operating or data selecting cycle has been completed; i. e., to prevent shifting intermediate a punch selecting or punch operating cycle.

Another object is to provide novel means for punching a record card while the card is continuously moving.

The above object includes means for continuously moving the punch selecting mechanism in synchronism with the feed of the card.

Still another object is to provide means for moving the punch selecting mechanism step by step, intermittently, and under manual control to select data to be punched.

The above object is combined with the object of providing means for moving the same punch selecting means continuously during a punching cycle; thus one means is provided to intermittently move the punch selecting mechanism step by step during data selection and another means to move the punch selecting mechanism continuously during punch operation.

Another object is to provide a novel form of punch selecting mechanism in which punch selection is effected by removable, interchangeable, interposing elements.

The above object, more specifically, includes provision of a punch selecting mechanism having interposer receiving elements any of which may receive any of a plurality of interposer elements.

Still more specifically, the latter object is to provide interposers in the form of balls or the like which may be set or loaded interchangeably into ball receiving pockets of a punch selecting mechanism.

A further object is to provide means for correcting an erroneous punch selection; i. e., as by back-spacing the punch selecting mechanism; nullifying the previous punch selection, and making another punch selection.

Still another object is to provide means for, at will, releasing the punch selecting mechanism to a final punch selecting position, without requiring intermediate steps of punch selecting operation.

Another object is to provide a punch selecting mechanism which may be moved from an operative position in the machine to an inoperative position in which it may be inspected and parts removed or changed.

Other objects will appear from the following portions of the specification and from the drawings, in which:

Fig. 1 is a plan view of the machine, with most of the covering removed to show the interior mechanism.

Fig. 2 is a side view of the machine with the side cover plate of the punching section removed to show interior mechanism.

Fig. 3 is a detail of the esecapement mechanism which feeds the punch selecting mechanism step by step.

Fig. 4 is a section along lines **4—4** of Fig. 1.

Fig. 5 is a left side view of driving gear of the machine.

Fig. 6 is a sectional, side, view of punch selecting mechanism, particularly the loading means for such mechanism.

Fig. 6*a* is a detail view showing how a tooth of the back space release shutter blocks release of a ball.

Fig. 7 is a rear sectional view through the lower portion of the punch selecting mechanism showing the interposer (ball) dumping means.

Fig. 8 is a section along lines **8—8** of Fig. 7.

Fig. 9 is a top view of the ball dumping mechanism.

Fig. 10 is a rear view, partly sectioned, of the ball (interposer) feeding means.

Fig. 11 is a section along lines **11—11** of Fig. 10.

Fig. 12 is a section along lines **12—12** of Fig. 10.

Fig. 13 is a plan section through the escapement drive.

Fig. 14 is a front section along lines **14—14** of Fig. 4.

Fig. 15 is a side view of the card supply magazine and feeding means for the card.

Fig. 16 is a rear view of the card magazine and card feeding means.

Fig. 17 is an enlarged side view of the punch selecting or loading mechanism, partly sectioned.

Fig. 18 is a front end view of part of the escapement mechanism.

Fig. 19 is a detail view of an element of the release means of the escapement mechanism.

Fig. 20 is a section along lines **20—20** of Fig. 1.

Fig. 21 is a section along lines **21—21** of Fig. 20.

Fig. 22 is a section through the typewriter unit showing the punch and type selecting or setting up means.

Fig. 23 is a section along lines **23—23** of Fig. 1.

Fig. 24 is a section along lines **24—24** of Fig. 1.

Fig. 25 is a section along lines **25—25** of Fig. 24.

Fig. 26 is a front, fragmentary, view of the typewriter frame showing the means for indicating the progress of the punch selection.

Fig. 27 is a fragmentary view of the left side of the machine, particularly showing the operating means for the punch selection progress indicating means.

Fig. 28 is a section along lines **28—28** of Fig. 27.

Fig. 29 is a section along lines **29—29** of Fig. 27 on an enlarged scale.

Fig. 30 is a section along lines **30—30** of Fig. 13.

Fig. 30*a* is a detail view of part of the release means also shown in Fig. 30.

Fig. 31 is a detail view of an escapement control element.

Fig. 32 is a section along lines **32—32** of Fig. 13.

Fig. 33 shows a portion of the tabulating card indicating the punch code.

Fig. 34 is a section along lines **34—34** of Fig. 23.

Fig. 35 is a section along lines **35—35** of Fig. 23.

Fig. 36 is a top view of parts shown in Fig. 23.

Fig. 37 is a rear view of part of the driving gear taken generally along lines **37—37** of Fig. 5.

Fig. 38 is a rear, partly sectional, view taken along lines **38—38** of Fig. 5.

Fig. 39 is a rear view of a fragment of the punch repeat control mechanism.

Fig. 40 is a side view of the rear portion of the punch repeat control means.

Fig. 41 is a view of the left side of the escapement mechanism, with parts broken away to show interior mechanism.

Fig. 42 is a detail view, partly in section of the escapement control pin wheel.

Fig. 43 is a bottom view of the ball cylinder housing and of parts carried thereby.

Fig. 44 is a rear view of the ball cylinder housing.

Fig. 45 is a plan view of the card feeding and punching mechanism.

Fig. 45*a* is a detail sectional view of a part of the punch assembly.

Fig. 46 is a vertical sectional view through the punching mechanism, showing a single punch.

Fig. 47 is a plan view of the upper layer of six loading magnets and their related elements.

Fig. 48 is a section along lines **48—48** of Fig. 32.

Fig. 49 is a detail, perspective, view of the back space ball return trough.

Fig. 50 is a bottom view of the intermediate portion of the machine.

Fig. 51 is a top view of the ball return trough and ball feeding means looking from the rear.

Fig. 52 is a view showing a typical invoice and card prepared by the machine.

Fig. 53 is a timing diagram, and

Fig. 54 is a circuit diagram.

Briefly, the machine has a typewriter unit, operation of the keys of which simultaneously effects printing on an invoice blank and selection of punches. The selection of the punches is effected by placing interposers in receivers. The receivers are cylinders with pockets and the interposers are balls loaded into the pockets. After a cylinder is loaded, it is shifted under manual control to a punch operating station. There it cooperates with punch pins to punch a card in accordance with the set-up of the balls in the ball cylinder. While the one ball cylinder is at operating station effecting punch operation in accordance with a previous set-up, another ball cylinder is being loaded by operation of the typewriter keys to select a different set-up. Thus, it is not necessary to wait for one card to be punched before effecting another punch selection.

After a punching operation under control of a ball cylinder, those balls corresponding to data varying with each card are released or dumped from the cylinder, while the remaining balls set up according to data common to several cards to be punched are retained in the cylinder. This is done under control of punch repeat mechanism.

It is to be understood that the punching mechanism may be operated independently of a typewriter, by using a keyboard or the like character selecting devices without connected typing or printing mechanism. It is further to be understood that instead of using a pair of punch control cylinders only one may be used when it is satisfactory to effect punching and punch selecting in succession instead of in overlapping time relationship.

The invoice and the tabulating card

The card T is known in the art as a tabulating or record card. As shown in Fig. 52, the card has eighty vertical columns of index point or perforation receiving positions. There are twelve positions in each column, arranged as indicated in Figs. 33 and 52. The punch code used herein is illustrated in Fig. 33. Numbers 0 to 9 are represented by punching a single hole in the corresponding 0 to 9 index point positions of the card columns. The letters of the alphabet and the period (punctuation mark) are represented by two hole combinations of perforations in the card columns. In addition, the "11" and "12" positions, respectively known as the X and D positions may be perforated to control tabulating operations.

As indicated in Fig. 52, the left hand section of the card contains repeat data; i. e., such data as is common to a single transaction of several separate items. This repeat data is punched on a plurality of cards, each card relating to a different item of the single transaction. The right hand section of the card contains individual data; i. e., data peculiar to one particular item and punched only on one card.

The invoice B shown in Fig. 52 is merely exemplary. It contains the data of several individual items sold to one customer. The data is taken from sales slips, or other original sources, to be typed in on the invoice. The date, October 5, 1929, is not to be punched in this form but in coded form, into card T.

As shown in Fig. 52, the first two card columns are punched in positions 2 and 9 to represent year '29; the next column is punched in position 0 to represent the tenth month, and the next two columns are punched with the day designations 05. The coded form of the date, the invoice number, the customer number, the town, State, classification, branch, salesman, and customer's name are to be punched in the Repeat data section of the card, since this data is common to the entire list of items on the bills. The quantity, commodity number, unit number, and amount of one item on the list is to be punched in the Individual data section of the card. For each separate item, a separate card will be punched containing the repeat data and the individual data pertaining only to one item. The freight data and account number card column are not to be perforated with data in this particular example. The X position of the first freight column is accordingly perforated to cause the succeeding columns to be skipped over by the punching mechanism, as will be later described.

Typewriter unit

While the typewriter used may be of any suitable design, the one selected for purposes of the invention is of the type shown in Patent No. 1,777,055, with such changes as are required by the present invention.

Referring to Figs. 1 and 22, the typewriter keyboard has the usual numerical and alphabetical character keys **10**. Depression of a key **10** releases a latch **11** from one of a pair of opposite cams **12**, permitting a spring-pressed lever **13** to bring the cam against a friction roller **14** continually rotated by a motor (not shown) supplied within the typewriter unit.

When a cam **12** is brought against roller **14**, the latter imparts half a turn to cam **12** and then the latch **11** again arrests the cam in a position disengaged from the roller. The cam is eccentrically carried by a pivoted frame **15**, and rotation of the cam is in such a direction as to cause frame **15** to depress connected link **16** for rocking a lever **17** counterclockwise (Fig. 22). Each lever **17** is connected through linkage **18** to a type bar **19**. When lever **17** is rocked counterclockwise, due to depression of the associated key **10**, the lever acts through linkage **18** to propel the type bar **19** against platen P to type the character selected by the key **10**.

A curved universal bar or bail **20** extends across all the type bars and is resiliently urged towards the type bars. The final increment of movement of a type bar towards the platen is effected by momentum, and during such movement and before the type bar can effect printing, it strikes bail **20** to move the latter for effecting letter spacing, escapement operation of the typewriter carriage **233** (Fig. 2). The letter spacing means connected to bail **20** is fully disclosed in Patent No. 1,873,512.

For reasons which will appear later, it is sometimes desired to operate a key **10** to cause rotation of the associated cam **12** without producing either a typing or letter spacing operation. For this purpose, a special, non-print key **21** is provided at the right side of the key-board. Key **21** is similar to the other, character, keys, and is similarly pivoted and resiliently urged upwardly. The right end of key **21** is connected through a link **22** to an arm **22'** dependent from and rigidly secured to a shaft **23**. Shaft **23** carries an arm **24** which rigidly supports a curved spring metal plate **24'** located behind universal space bail **20**.

When key **21** is in initial position, plate **24'** is remote from bail **20**, permitting normal operation of the bail. Whenever key **21** is depressed, through link **22** and arm **22'**, it rocks shaft **23** counterclockwise (Fig. 22), causing spring plate **24'** to move upwardly and against the rear edge of universal bail **20**. As a result, when a key **10** is subsequently depressed and the associated type bar during its final increment of free, momentum-actuated movement strikes bail **20**, then the latter being restrained by spring plate **24'** is unable to move to the rear. Since bail **20** cannot move to the rear, then the type bar cannot move to complete its stroke and, therefore, does not print. Also, since bail **20** does not move, no letter spacing operation of carriage **233** takes place. Due to the arrest of the type bar **19** and space bail **20** taking place during the momentum-propelled, final increment of movement of bar **19**, the associated cam **12** is able to complete its rotational step. Thus, depression of non-print key prevents typing and letter spacing but does not interfere with rotation of the cam **12**.

Supplementing the key mechanism is contact-closing means comprising levers **25**, one for each of the opposite cams **12**. When a cam **12** rotates, it engages roller **25'** of lever **25** to rock the latter against resistance of a spring **26**. The lower end of each lever **25** has a stud **27** seated in a cam recess **28'** in the bottom of a horizontally extending arm of a bell crank **28**. The bell cranks **28** are engaged at their upper ends with spring blades **29**, each carrying one of the points of a switch **30**, the other point of which is on a companion blade **31**. Some of the bell cranks **28** are also associated with an additional switch **32**, the points of which are carried between spring blade **31** and a companion blade **33**, as indicated at the left in Fig. 22.

When a key **10** is depressed, it causes rotation of a cam **12** to rock a lever **25** which, in turn, through coaction of its pin **27** with cam recess **28'** of a bell crank **28** moves the latter in a direction to close either switch **30** or switches **30** and **32** depending on whether the one or both switches are associated with the key 10 and the corresponding bell crank 28.

According to the punch code illustrated in Fig. 33, the numbers are represented by single hole punchings in a card column while the letters of the alphabet are represented by combinations of two hole punchings in a card column. As will be brought out later, switches 30 and 32 each select means to make a single punched hole in a card column. Thus the numerical character keys 10 are correlated with the single switches 30 to cause selection of single hole punchings while the alphabetical character keys are correlated with the two switches 30 and 32 to cause selection of two hole punchings.

It may also be noted from the code in Fig. 33 that the 11 index point position may be perforated to designate a special X while the 12 index point position is perforated to represent a special D designation. Also, an 11 index position perforation may represent number 11, as numerically symbolizing the 11th month, November; and likewise the 12 index position perforation may represent value 12. Further, it may be noted that the representation of numerical "1" is distinct from the representation of letter L. To take care of the selection of the special X and special D punchings, which are not accompanied by printing operations, the keyboard (Fig. 1) is provided with special X key 10—*x* and with special D key 10—d. The special X key is also used to initiate skipping of punch selections of selected columns, and may be referred to as a skip key. Neither of keys 10—*x* or 10—*d* has a type linkage associated therewith so that their depression will not cause either a printing or a typewriter carriage feed.

The L key 10 is ordinarily used to cause typing of both the "1" and the "L" characters. Here, however, since the "L" punched representation is different from the "1" punched representation, a special numerical "1" key 10—1 is provided for selecting the "1" punching and printing, while the L key is used only to select "L" punching and typing.

Each lever 25 has a shoulder 34. Each of the two rows of levers 25, one at each side of the shaft 14, has its shoulders 34 underlying the tip of one of a pair of similar common bails 35, each bail fixed to a separate shaft 36. Fast to each shaft 36 is an arm 37 provided with a stud 38 coacting with a cam recess 38' in the lower arm of a bell crank 39. The upper end of bell crank 39 is opposite spring blades 39' carrying between them contacts 40 and 40'. Whenever a key 10 is depressed to cause rocking of a lever 25 to close switches 30 and 32, shoulder 34 of the lever 25 acts on the tip of the associated bail 35 to rock shaft 36 in a direction to move its arm 37 upwardly. The upward movement of arm 37 causes its stud 38 to coact with cam recess 38' of lever 39 to rock the latter in a direction to close contacts 40 and 40'. The two pairs of contacts 40 and 40', one pair associated with the left hand row of levers 25 and the other pair with the right row of levers 25 (Fig. 22) have a similar function and only one pair of contacts 40 and 40' will be shown in the circuit diagram, Fig. 54. It is clear that depression of any key 10 causes typing of the selected character, letter spacing operation, the closing of a pair of contacts 30, with or without accompanying closure of a pair of contacts 32, and also closure of a pair of common contacts 40 and 40'. When non-print key 21 is depressed, the subsequent depression of a key 10 effects all of above results except the typing and letter spacing operations.

The several contacts 30, 32, 40, and 40' are closed only momentarily by operation of keys 10, due to the quick return of the cams 12 to initial, latched positions.

As stated before, invoice B to be typed in the machine may have a plurality of individual items billed to a single customer. The machine is intended to prepare a separate tabulating card T for each individual item. A card T is not only to contain the data of the individual item but also the repeat data common to several cards. In order to avoid repeating the punch selections for the common data—which is typed in only once—a repeat key 41 (Figs. 1, 20 and 21) is depressed.

Referring to Figs. 20 and 21, depression of key 41 against resistance of its spring 41' causes a pin 42 extending from the stem of the key to engage the inclined upper end of a spring blade 43 to close normally open constant data contacts 44. Key 41 is retained in depressed position by a pivoted lock bar 45 which enters a notch 46 in the key when the latter is depressed. In front of key 41 is a release key 47 therefor which in normal position has a notch 48 engaged by lock bar 45. When key 47 is depressed against resistance of its spring 49, the upper inclined side of notch 48 cams bar 45 counterclockwise (Fig. 21) against resistance of a spring 50 connected to the lock bar (see Fig. 20) thereby releasing the lock bar from notch 46 of key 41. Spring 41' then returns key 41 to its normal, inactive position. When release key 47 is relieved of the pressure of the operator's finger, spring 49 returns the release key to the normal position shown in Fig. 21.

As will be clear from subsequent portions of the description, the punch selecting operations cannot begin until repeat key 41 is depressed. Accordingly, before depressing repeat key 41, the operator types in preliminary data on the invoice which is not to be selected for punching while being typed. In the example shown in Fig. 52, the order designation (E789) and the conventional form of the date (October 5, 1929) are first typed in; then following this typing operation, the repeat key is depressed.

The first five columns of the card T (Fig. 52) are to be punched with coded representations of the numerical symbolic form of the date. In the illustrated example, positions 2 and 9 are to be punched in the year columns, 0 (representing the tenth month) in the month column, and 0, 5 in the day columns. The keys 10 for setting up these date designations are operated while holding down non-print key 21 to avoid printing this matter on the invoice.

When a number key 10 is depressed to set up a numerical item, it causes the associated switch 30 to close and, at the same time, causes closure of contacts 40 and 40', as already explained. Also, constant data contacts 44 are now closed.

With constant data contacts 44 closed, the closure of contacts 40' forms the following constant data circuit, referring to Fig. 54.

Circuit A.—From line 52, through contacts 44, normally closed contacts 56*a*, contacts 40', lower relay contacts 53*a* (closed during the first punch selecting operation, as will be further explained), magnet 54, and to line 55.

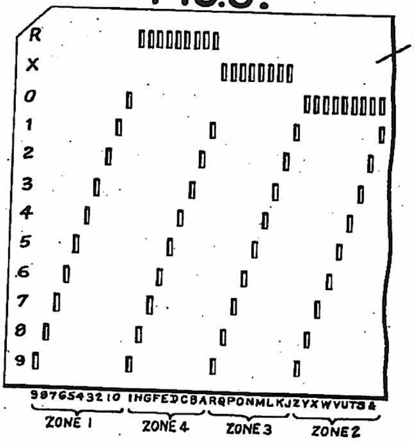
Simultaneously the following loading circuit is formed:

Circuit B.—From line 52, through contacts 44, contacts 56*a*, contacts 56 (now closed), switch 30, a loading magnet 58 or 58', contact stud 59 or 59', March 15, 1938. A. W. MILLS ET AL 2,111,122

PRINTING MECHANISM

Filed Dec. 22, 1936 5 Sheets-Sheet 4

FIG.5.



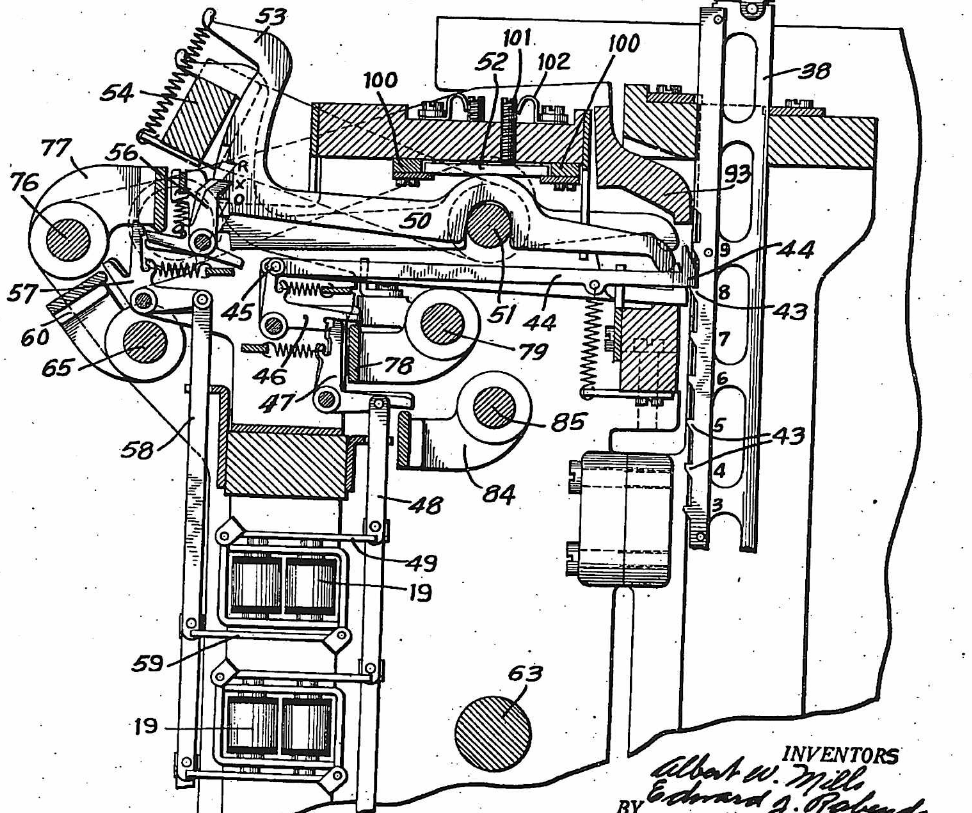


FIG.4.

INVENTORS

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BY Edward J. Rabenda

ATTORNEYS.

Dec. 7, 1943. E. BUHLER 2,335,911

PRINTING MECHANISM

Filed Dec. 18, 1940 4 Sheets-Sheet 1

FIG.1.

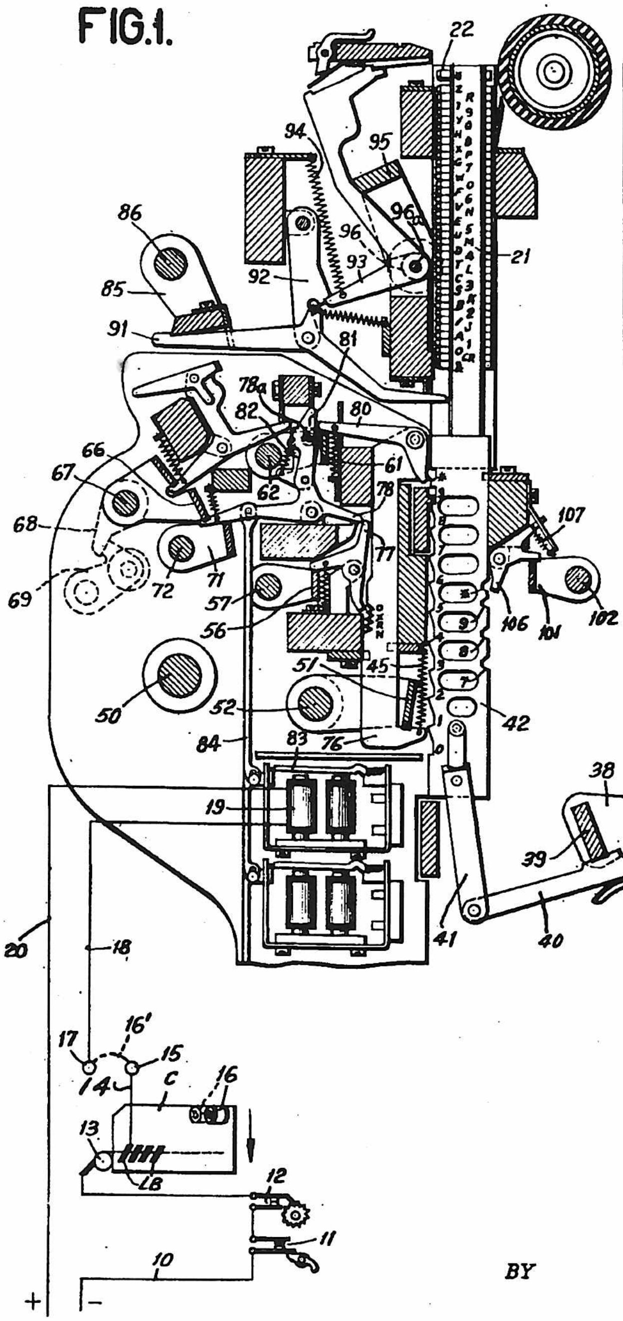
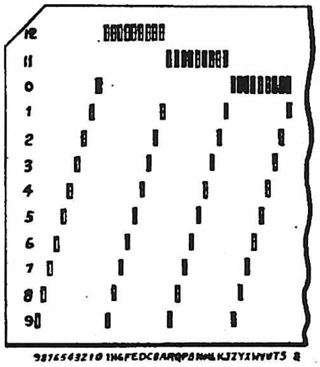


FIG.6.



INVENTOR
Eugen Buhler

BY

ATTORNEY

Snyder

IBM
ELECTRIC PUNCHED CARD
ACCOUNTING MACHINES

PRINCIPLES OF OPERATION

COLLATOR
TYPE 77

JAN 23 1961
LIBRARY

INTERNATIONAL BUSINESS MACHINES CORPORATION
NEW YORK, NEW YORK

ag

Copyright, 1945
International Business Machines Corporation
590 Madison Avenue, New York, New York

Printed in U.S.A.

Form No. 52-3185-1—6M—3792ME—6-51

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ALPHABETIC COLLATING DEVICE

The Alphabetic Collating Device can be specified as an extra feature to perform merging, matching and selecting of cards according to names, titles or other alphabetic information punched in the cards. As many as eight columns of alphabetic information can be used for those operations which require control of sequence and selection—that is, for those operations for which the capacity of the machine is 16 numerical positions. Without selection or sequence control, as for the merging of two sets of cards, 16 columns of alphabetic information can be read. This corresponds to numerical operations in which up to 32 numerical positions are used.

Two control positions are required for each alphabetic character because each is interpreted by the machine as a two-digit number. Three additional reading brush stations are installed to read the zone punching in 16 specified columns of the card. Corresponding hubs, located near the center of the panel, are labelled *secondary zone brushes, primary zone brushes,* and *primary sequence zone brushes.* As the names imply, only zone punches are read, but a zero zone is read as an *8*, an eleven (X) zone is read as a *7*, and a twelve zone is read as a *6*. With a regular brush wired normally to any magnet and a zone brush wired to a magnet immediately to the left, a letter is sensed as a two-digit number. An *A* (*12-1*) is read as 61; the twelve zone punch reads as a 6 and the lower punching normally as 1. The letters A through I are read as numbers from 61 to 69, the letters J-R read as 71-79, and the letters S-Z read as 82-89.

Since letters are read as numbers, the operation of the machine for alphabetic information is the same as the operation for numerical information except that each letter requires two magnet positions. The wiring for filing (or comparing) two sets of cards by 8 positions of name punched in each set is shown in Figure 56. Name cards in either set not matched by corresponding names in the other set will be selected.

The merging of two sets of cards in alphabetic sequence can be performed by reading up to 16 columns of alphabetic information. In this case, the wiring would be similar to that shown in Figure 41 for merging with up to 32 columns of numerical information. The only difference is the use of two magnet positions for each alphabetically punched column; the right-hand position of each two is wired from the regular brushes and the left-hand position is wired from the zone brushes.

Letters and numbers punched in the same columns of different cards would rarely permit a satisfactory sorting or collating operation to be performed, since a zero would be read as 80 which falls between R (79) and S (62). However, the automatic interpretation of a letter as a number permits the use of letters and numbers at the same time if they are punched in different columns of the card. The number of positions which could be read in such a combination code is determined by counting two positions for each letter and one for each numeral.

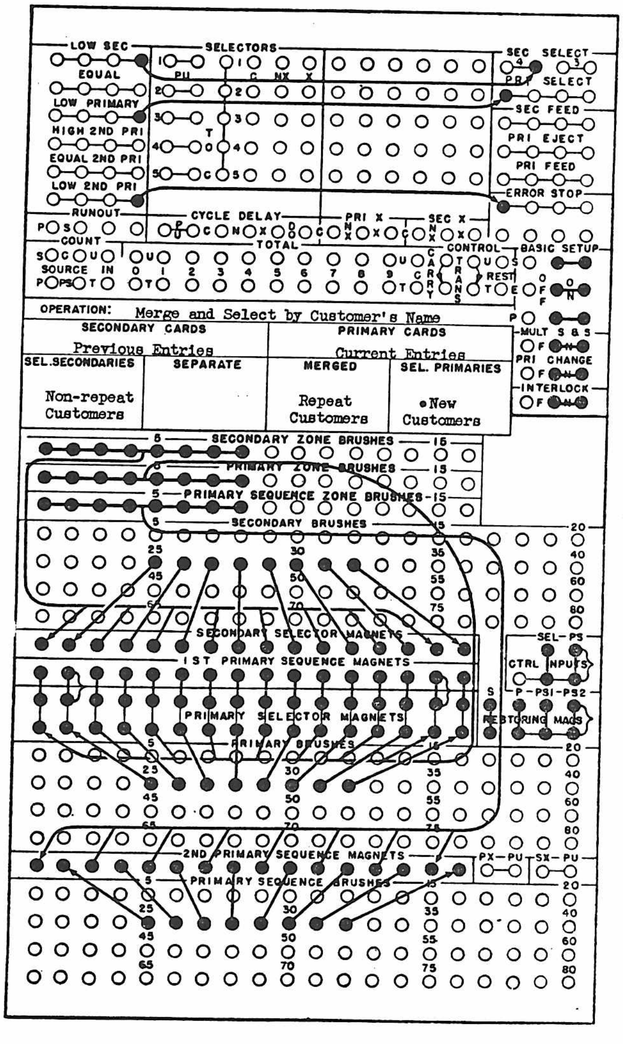


Figure 56

Patented Feb. 13, 1945 **2,369,474**

UNITED STATES PATENT OFFICE

2,369,474

CODE TRANSLATOR

Hans P. Luhn, Armonk, N. Y., assignor to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application December 10, 1943, Serial No. 513,817

4 Claims. (Cl. 178—26)

This invention relates to a code translator, and more particularly to a translator for translating the representation of a character expressed in one system of coding to an expression in a different system of coding.

A more particular object of the invention is to provide an all electric code translator, in which characters expressed in a six position system by combinations of one to four positions may be translated into a seven position system in which the characters are expressed by different combinations of one to five positions.

A more specific object is to provide a translator in which a number of relay magnets, one for each of the code positions of a given system, are energized in selected combinations to adjust related sets of contacts. These contacts are wired to form a number of chain relay circuits, equal in number to the greatest number of code positions concurrently employed in a second system, so that separate parallel circuits will be completed to represent a character in the second system.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawing, which discloses, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

The drawing represents the electric wiring of a translator in which combinations in a six position code are translated into other combinations in a seven position code.

The six position code in which characters are represented by combinations of 1, 2, 3 or 4 positions is known as the "Radiotype" code and the seven position code into which the characters are to be translated into combinations of 1, 2, 3, 4 or 5 positions is known as the "Teletype" code. The combinations of the several characters are set forth in the table below, where under "code A" are the combinations for the initial code and under "code B" are the combinations for the resultant code.

Character	Code A, positions						Code B, positions						
	1	2	3	4	5	6	1	2	3	4	5	F	L
A	1	---	---	---	---	6	1	2	---	---	---	---	L
B	1	---	3	---	5	---	1	---	---	4	5	---	L
C	---	---	---	4	5	---	---	2	3	4	---	---	L
D	---	---	3	---	5	---	1	---	---	4	---	---	L
E	1	---	3	---	---	---	1	---	---	---	---	---	L
F	---	---	---	4	---	6	1	---	3	4	---	---	L
G	1	---	3	4	---	---	---	2	---	4	5	---	L
H	---	---	3	4	---	---	---	---	3	---	5	---	L
I	---	2	---	4	---	---	---	2	3	---	---	---	L
J	---	2	3	4	---	---	1	2	---	4	---	---	L
K	1	---	---	4	5	---	1	2	3	4	---	---	L
L	---	---	3	---	---	6	---	2	---	---	5	---	L
M	1	2	3	---	---	---	---	---	3	4	5	---	L
N	---	2	3	---	---	---	---	---	3	4	---	---	L
O	1	---	---	---	5	---	---	---	---	4	5	---	L
P	1	2	---	4	---	---	---	2	3	---	5	---	L
Q	1	---	---	---	5	6	1	2	3	---	5	---	L
R	---	2	3	---	---	6	---	2	---	4	---	---	L
S	---	2	---	---	---	6	1	---	3	---	---	---	L
T	1	---	---	4	---	---	---	---	---	---	5	---	L
U	---	---	---	---	5	---	1	2	3	---	---	---	L
V	1	---	3	---	---	6	---	2	3	4	5	---	L
W	1	2	---	---	5	---	1	2	---	---	5	---	L
X	1	---	---	4	---	6	1	---	3	4	5	---	L
Y	1	2	---	---	---	6	1	---	3	---	5	---	L
Z	---	2	---	4	---	6	1	---	---	---	5	---	L
1	1	---	---	---	---	---	1	2	3	---	5	F	---
2	---	2	3	---	5	---	1	2	---	---	5	F	---
3	---	2	---	---	5	6	1	---	---	---	---	F	---
4	---	---	3	4	5	---	---	2	---	4	---	F	---
5	---	---	3	4	---	6	---	---	---	---	5	F	---
6	---	---	3	---	5	6	1	---	3	---	5	F	---
7	1	---	---	4	5	6	1	2	3	---	---	F	---
8	1	2	3	4	---	---	---	2	3	---	---	F	---
9	1	2	3	---	5	---	---	---	---	4	5	F	---
0	1	2	---	4	5	---	---	2	3	---	5	F	---
TAB	---	---	3	---	---	---	---	2	---	4	5	F	---
CR	---	2	---	---	5	---	---	---	---	4	---	---	L
.	---	2	---	4	5	---	---	---	3	4	5	F	---
,	1	2	3	---	---	6	---	---	3	4	---	F	---
:	---	2	---	4	5	6	---	2	3	4	---	F	---
?	1	2	---	4	---	6	1	---	---	4	5	F	---

Referring to the drawing, six magnets 10 are provided which may be energized combinationally in accordance with the coding of the table designated code A, and the specific manner in which they are energized is not shown. Each magnet is provided with multiple armatures shown arranged in horizontal alignment therewith and numbered consecutively from left to right. Thus, the 1 magnet 10 has nineteen armatures, the 2 magnet 10 has thirty armatures, the 3 magnet 10

June 12, 1945.

H. L. THOLSTRUP

2,378,371

TRANSCRIBING APPARATUS

Filed June 30, 1943

9 Sheets-Sheet 1

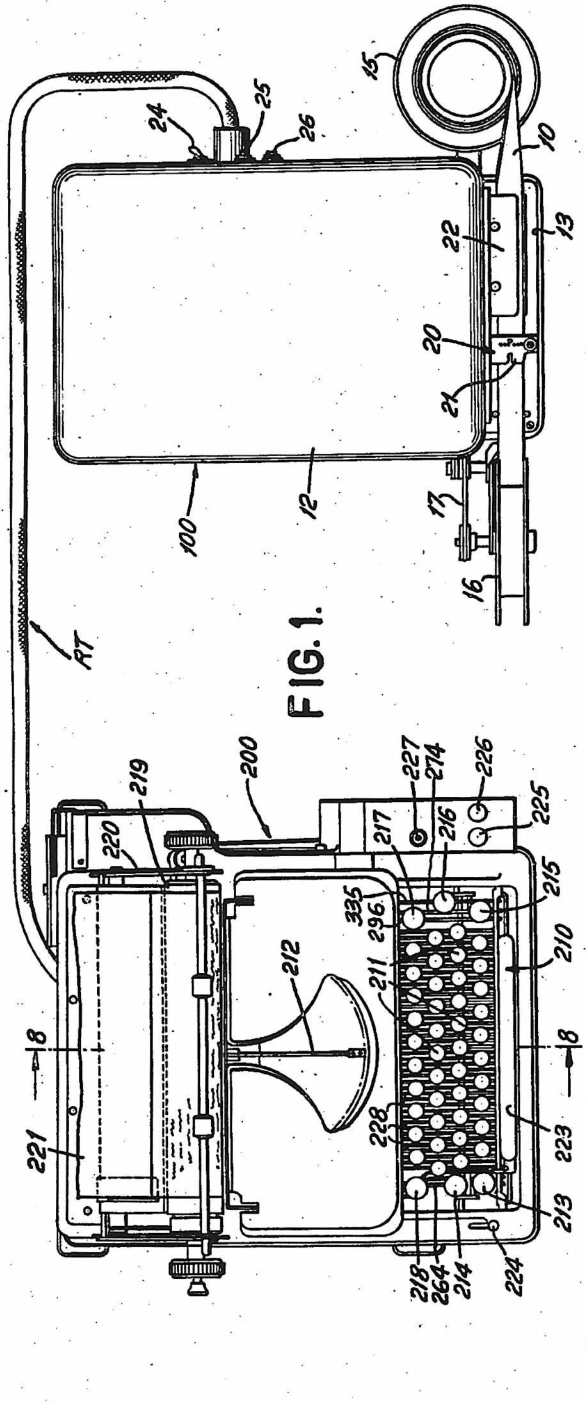
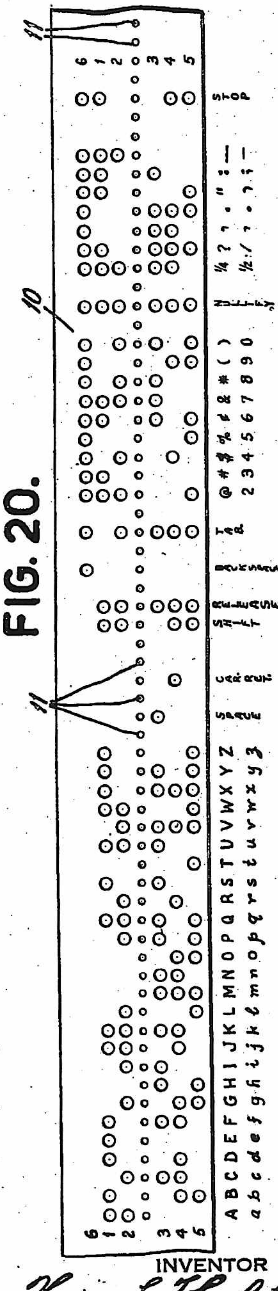


FIG. 1.



10
11
11
6
1
2
3
4
5
STOP
NULLIFY
TAB
BACKSPACE
RELEASE
SHIFT
CAR RET
SPACE
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z
@ # $ % ¢ & * ( )
2 3 4 5 6 7 8 9 0

FIG. 20.

INVENTOR

Henry L. Tholstrup

BY

W. M. Wilson

ATTORNEY

Oct. 9, 1945. H. S. BEATTIE 2,386,422

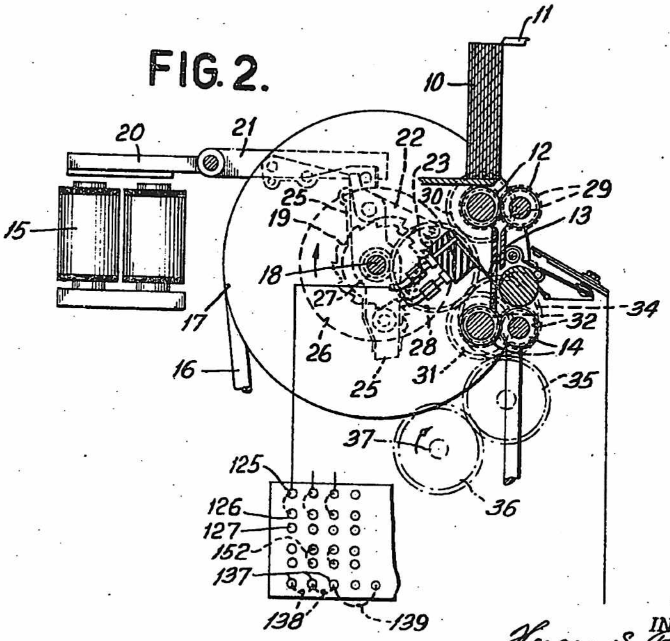
ALPHABETIC PRINTING MECHANISM

Filed Feb. 19, 1943 6 Sheets-Sheet 1

FIG. 1.

PILOT HOLE	NONE	R	X	O	PILOT HOLE	R	X	O	NONE
HOLE	NUMERAL	TYPE-CAPITALS OF ALPHABET			HOLES	TYPE-LOWER CASE OF ALPHABET			
1	1	A	J		1-0	a	j		$
2	2	B	K	S	2-1	b	k	s	,
3	3	C	L	T	3-2	c	l	t	.
4	4	D	M	U	4-3	d	m	u	:
5	5	E	N	V	5-4	e	n	v	;
6	6	F	O	W	6-5	f	o	w	*
7	7	G	P	X	7-6	g	p	x	CR
8	8	H	Q	Y	8-7	h	q	y	DR
9	9	I	R	Z	9-8	i	r	z	—
0	0								

FIG. 2.



INVENTOR
Horace S. Beattie

BY

ATTORNEY

The Journal of the Institution of Electrical Engineers
vol 92, part I, no. 60 December 1945

DONALD MURRAY, M.A., was born at Invercargill, New Zealand, in 1866, and died at Territet, Switzerland, on the 14th July, 1945. After leaving the University at Sydney, he took up journalism, for he had a facile pen. He was also a born mechanic, so that the mechanical features of a newspaper office attracted him, and ideas of setting type by telegraph began to germinate in his mind. In 1898, when these ideas had taken a practical form, he went to New York, where he joined the staff of the Postal Cable Co. Two years later he came to London and for a short time worked at the General Post office on the development of his first system of printing telegraphy. This system was fully described in his paper on "Setting Type by Telegraph," which was published in the *Journal* in 1905 and for which he was awarded the Fahie Premium. The paper marked an era in the presentation of papers on telegraphy; among other things it laid down the fundamentals required of a successful printing telegraph system with respect to the form of alphabet or code to be employed.

He then designed a system of multiple telegraphy which possessed important advantages over that of Baudot: his phonic-wheel motor, in combination with Baudot's epicyclic correcting train, gave such excellent synchronism that it was adopted by the French Telegraph Administration. This system was described in a second paper, entitled "Practical Aspects of Printing Telegraphy," which was published in the *Journal* in 1911 and for which he was again awarded the Fahie Premium. In 1914–15 he contributed a series of articles to the *Telegraph and Telephone Journal*, entitled "Press the Button Telegraphy," and in 1925 he was awarded the Paris Exhibition Premium for his Institution paper on "Speeding up the Telegraphs: a Forecast of the New Telegraphy."

Murray sold his American rights in his multiplex system, but he retained its manufacture and sale in Europe in his own hands until his retirement. As an employer he was stern but just. Nothing but the best work was good enough for him, and he gathered around him a group of craftsmen who were unrivalled.

In his later life abroad he engaged in literary work. Two of his books, "The Philosophy of Power" and "The Theory of Control" have been published. A third book, "Speeding up the Railways" is unfinished; he was half-way through this, in 1940, when brain trouble set in. He underwent three operations at Monte Carlo, after which he and Mrs. Murray moved into Switzerland; but he was too ill to take up his work again and lingered on in a state of invalidism, never fully recovering.

He became a Member of The Institution in 1910. In the field of machine telegraphy his name deserves to rank with those of Wheatstone, Kelvin, Baudot and Gulstad. H. H. H.

COLONEL GUY DURAND OZANNE, M.C., who died on the 12th February, 1944, at the age of 54, was the elder son of Lieut. Col. C. H. Ozanne and Louisa Durand Kershaw. He was educated at King's School, Rochester, and, like his father before him, at Elizabeth College in Guernsey, the homeland of the Ozannes and the Durands. Passing out of Sandhurst in 1909, he was attached to the 2nd Royal Berkshire Regt. until he joined the 99th Deccan Infantry, Indian Army, in 1912. During the War of 1914–18 he served in East Africa as Regimental, Brigade and, finally, Divisional Signals Officer, having been promoted to field rank in 1917. He was in action at Tanga and Bushoba and, besides being mentioned twice in despatches, was awarded the M.C. He retired from the Indian Army in 1923.

On returning to England, Ozanne became interested in radio manufacture, and was Manager of the Radio Communication Co. from 1924 to 1926, when he joined Wingrove and Rogers. Notwithstanding his busy life in industrial affairs, he always found time and energy to devote to the London Territorials: from 1930 to 1935 he was Officer Commanding the City of London Signals, and later was Deputy Chief Signal Officer. From 1940 until the time of his death, he was engaged on special military duties.

During the last two years of his life he served on the Council of the Guernsey Society in London, and played an active part in the efforts of that Society to alleviate the misery of the Islanders under the German occupation. He had also served as Chairman of the Electric Vehicle Association and of the Radio Component Manufacturers' Association. He was deservedly popular with all his professional colleagues: it was an outstanding trait of his character that he never discussed his associates unless his comments were favourable, courteous and kindly. He lived a full and many-sided life as soldier, electrical engineer and man of affairs. He is survived by his widow.

He joined The Institution as an Associate Member in 1923 and was elected a Member in 1928; he served as a member of the Wireless Section Committee from 1938 to 1941. E. B. M.

ROMUALD VICTOR PICOU, a former President of the Société Française des Électriciens, died in Paris on the 21st September, 1942. He was born at Saint-Denis (Seine) on the 24th July, 1855, and was educated at the lycées Louis-le-Grand and Saint-Louis. He became a student at the École Centrale des Arts et Manufactures in 1873 and, on the termination of his studies in 1877, was awarded an engineering diploma. In the same year he illuminated a small workshop by means of a Serrin arc-lamp mounted on rails fixed to the ceiling, and operated by a Gramme dynamo; the prime mover was a Brotherhood three-cylinder steam-engine. The successful operation of this plant led to similar installations, and from these small beginnings were laid the foundation of Picou's career as an electrical engineer. The Paris Electrical Exhibition of 1881 gave the young enthusiast his opportunity, for he was invited by a group of French financiers to report on the first Edison lamps and system of generation and distribution, which were there exhibited. His favourable report led to the formation of the French Edison Company in January 1882, and he was engaged to supervise the erection at Ivry of a factory for the manufacture of electric lamps and plant. A few months later he was sent to the United States, where he met Edison and gained experience in central station construction and in Edison's laboratory at Menlo Park. On his return to France in 1883 he became Director of the factory at Ivry and was responsible for the equipment of the generating station at the Avenue Trudaine, Paris.

In 1890, in private practice, he undertook the design and construction of a number of generating stations for various organizations, and he was responsible for the first power supplies at Soissons, Epernay, Saint-Quentin, Elbeuf, Trouville, Algiers, Oran, Alexandria, Cadiz, etc. He also acted as consultant to the Société Lebon and other electrical manufacturing concerns and undertakings, and in 1893 was closely associated with the setting up of the Bureau de Controle des Installations Électriques, of which he was appointed Director. He was appointed Engineer-in-Chief of Electrical Services at the Paris Exhibitions of 1889 and 1900.

He was the author of several textbooks and many articles on dynamo-electric machines, distribution of electricity, magnets and cognate subjects. For ten years he lectured at the École Nationale des Ponts et Chaussées. At the end of a long and active life Picou had gained the reputation of a genial scientist, ever ready to help or to collaborate with his colleagues.

He was a Foundation Member of the Société Française des Électriciens (then known as the Société Internationale des Électriciens), and became its President in 1898; subsequently he was elected President of Honour. He joined the Société des

HHH = H. H. Harrison? (Murray 1925, p 260) http://finsysgp.com/macbob/Couples0/C111280.html

111280

Generation: D

Donald Murray, "The Inventor"

Born: 1866 Died: 1945
Father: John Murray

Patricia Cosgrave

[Home] [Index] [Picture Index]

[Picture] "The Inventor". Born invercargill.

See Encyclopedia Britanica, 11th Edition (date 1911, before it became thoroughly Americanised), page 521, for a good paragraph on his telegraph printer invention.

There is a book entitled "Murray Printing Telegraph" by Donald Murray, M.A. Sydney, 23/2/1905. Published by Unwin Bros., The Gresham Press, Woking, London. It is in the G.P.O. Library in St. Martins-le-Grand, 1970.

He was a pupil at Auckland Grammar School from 1880 till 1881 and also in 1875-7.

Copy of his "The Philosophy of Power" I obtained from our local library. It is in National Central Library, London and its number is 301-65183. Also a copy in the British Museum.

In London 1916. "Sold out Inventions" in 1925. Died at Territer (spelling?), Switzerland.

Donald Murray, B.A. Auckland, M.A. Sydney, M.I.E.E. London.

From the Journal of the Institute of Electrical Engineers, London. 1945. 92. pt 1.

Donald Murray, M.A. was born at Invercargill, New Zealand, in 1866 [actually it was on 20th September 1865. RLM] and died at Territet, Switzerland, on the 14th July, 1945. After leaving the University of Sydney he took up journalism, for he had a facile pen. He was also a born mechanic, so that the mechanical features of a newspaper office attracted him, and ideas of setting type by telegraph began to germinate in his mind.

In 1898, when these ideas had taken a practical form, he went to New York where he joined the staff of the Postal Cable Company. Two years later, he came to London and for a short time worked at the General Post Office on the development of his first system of printing telegraphy. This system was fully described in his paper on "Setting Type by Telegraph" which was published in the Journal in 1905 and for which he was awarded the Fahie Premium. The paper marked an era in the presentation of papers on telegraphy; among other things it laid down the fundamentals required of a successful printing telegraph system with respect to the form of the alphabet or code to be employed.

He then designed a system of multiple telegraphy which possessed important advantages over that of Baudot; his phonic wheel motor, in combination with Baudot's epicyclic correcting train gave such excellent synchronism that it was adopted by the French Telegraph Administration. This system was described in a second paper, which was published in the Journal in 1911, and for which he was again awarded the Fahie Premium. In 1914-15 he contributed a series of articles to the Telegraph and Telephone journal, entitled "Press the Button Telegraphy", and in 1925 he was awarded the Paris Exhibition Premium for his Institution paper on "Speeding up the Telegraphs; a Forecast of the New Telegraphy".

Murray sold his American rights in his multiplex system, but he retained its manufacture and sale in Europe in his own hands until his retirement. As an employer he was stern but just. Nothing but the best was good enough for him, and he gathered around him a group of craftsmen who were unrivalled.

In his later life abroad he engaged in literary work. Two of his books, "The Philosophy of Power" and "The Theory of Control" have been published. A third book, "Speeding up the Railways" is unfinished; he was half-way through this, in 1940, when brain trouble set in. He underwent three operations at Monte Carlo, after which he and Mrs. Murray moved into Switzerland: but he was too ill to take up his work again and lingered on in a state of invalidism, never fully recovering.

He became a Member of the Institution in 1910. In the field of machine telegraphy his name deserves to rank with those of Wheatstone, Kelvin, Baudot and Gulstad.

H.H.H.

[H.H.H. is dead. RLM]

I have a photocopy of the postscript to the article mentioned above as "Press the Button Telegraphy". It runs thus: "Notice! Attention is specially invited to the letter at the end of this pamphlet. I ask for the sympathy of all fair-minded men against the unscrupulous tactics of a big American Company, which is trying to deprive me of the legitimate fruits of my labour". Signed. Donald Murray.

This refers to an offer by the Western Electric Company which Donald considered inadequate. "The answer then made to me by the company was that they could get round any patents".

If you have read thus far in these notes you must have deduced something about the character of the compiler!

What do you make of the following extracts taken from Donald's book, "The Philosophy of Power"? Note, however, that Donald wrote it in the main around the years 1930-32. He was then 65-67 years of age. The book was published in 1939, probably a few months before the out-break of War. Presumably he revised it shortly before publication, when he was age 74. He had in view a work of six volumes of which this was the first. The local library obtained the copy for me to read from the National Central Library, London. It had apparently been taken out only twice before, once in August 1941, and once in June 1948. I wonder who these borrowers were! I could not get a copy of his second book, "The Theory of Control".

Extracts from "The Philosophy of Power".

Dedication.

I dedicate this work on the Philosophy of Power to all men of power; moulders of the destiny of mankind by work and deed; religious and secular leaders, philosophers, statesmen, inventive engineering and scientific pioneers, social organisers, builders of industry; and above all to Christ and Lucifer!

May those who are still with us, long be spared to serve their country and mankind; and when at last the Great Lady of Night comes to guide them, may the Winds of Ururangi, between the worlds, blow gently on their crossing.

Donald Murray.

Page 285. Stevinus and the inclined plane will be dealt with in a later volume, because Stevinus used the Conservation of Energy, apparently for the first time, to prove the principle of the inclined plane. He preceded Galileo.

Page 285. There is a strange muddle about the principle of reversibility and irreversibility, especially in regard to the steam-engine. People do not seem to know what they are talking about. The matter will be cleared up by a proper analysis in a future volume.

Page 291. But if Herbert Spencer is right in saying that all things proceed from Energy, then there is no Ether, unless it is a form of Energy. The question of the existence of a sub-stratum serving as the vehicle of energy will be considered in another volume.

Page 293. See Max Plank's Treatise on Thermodynamics, pp 103 and 104. His logic and arguments are excellent, but his basis is erroneous, and if I prove, as I shall, that the distinction between "perpetual motion of the first kind" and "perpetual motion of the second kind" is invalid, the whole of Max Planck's arguments will collapse like a house of cards. The classification of Nernst's Heat Theorem as the "Third Law of Thermodynamics" is now obviously absurd.

Thereafter follows a five page Appendix about Donald, written, (except the last paragraph) in the third person, obviously by himself. I quote therefrom now:

Donald Murray, Author of "The Philosophy of Power"

Biographical Notes.

Ancestry.

Member of the Murray Clan - a turbulent German tribe in Moravia, afterwards in the Black Forest. Also known as the Catti, and mentioned as such by Tacitus. The Romans got tired of the Morrayes and drove them out of Germany in the time of Nero, A.D. 60. They went down the Rhine, then sailed to the North of Scotland, where they made friends with the Scottish King and settled in Sutherlandshire and around the Moray Firth. In modern times some of these Northern Scottish peasant farmers came to Glasgow where they developed into bankers. One of them, John Murray, emigrated to New Zealand in 1863 and ultimately became head of the Bank of New Zealand. His son, Donald Murray, was born in New Zealand in 1865 and brought up in Auckland.

Education.

Suffered the usual idiocies of better-class English education in Canterbury, New Zealand, for two years. Had a first-class scientific and, particularly, electrical and mechanical education, combined with seventy two years of extremely varied experience all over the world, from Fiji to Moscow and Rio de Janeiro, including twelve years of newspaper work and twenty five years of telegraph engineering.

Career.

Farmer, New Zealand. Journalist, New Zealand and Australia. Printing Telegraph Engineer and Inventor, New York, London, Berlin, Petrograd. Philosopher, Monte Carlo. Several of Donald Murray's printing telegraph machines and models are in the South Kensington Science Museum in London.

Journalism.

In spite of two years at the Agricultural College, farming proved unsuitable. In 1886 went to Europe, round Cape Horn, wintered in Dresden, Germany, about 200 miles from the ancestral home of the Morrayes in Moravia, returning to Auckland, where he joined the staff of the New Zealand Herald, graduated B.A. in the New Zealand University, went to Sydney in 1891, joining the staff of the Sydney Morning Herald, and taking his M.A. degree in the Sydney University.

Telegraphy

(This section of the appendix is too long for me to quote in full. RLM). In 1899 Donald Murray went to New York with a telegraph invention, which was designed for setting type by telegraph by connecting the linotype to telegraph machinery, his motto being "this tape sets type". When it had reached practical form as the Murray Automatic Printing Telegraphy System, Donald Murray brought it to London in 1901. He left the Post Office in 1909 having established a Telegraph Engineering factory in London in conjunction with S.G. Brown, F.R.S., and he sold a number of his installations to Germany, Austria, Russia and Sweden, Brazil, Australia and New Zealand. It would be difficult to apportion the credit to each of the inventors concerned, but Donald Murray, F.G. Creed, (and 7 others. RLM) were leaders of the remarkable group of engineers, capitalists and inventors who revolutionised telegraphy. Donald Murray was the leader of the inventors on the theoretical side. The first newspaper in Europe to use the tele-typesetter was the Scotsman, under the guidance of W.P. Morris, transmitting about 40 columns a day from London and automatically setting it in type in the Scotsman office in Edinburgh. The Glasgow Herald has also adopted this remarkable machinery.

"I may take this opportunity to point out that my success as a telegraph engineer and inventor was based on THEORY, GENERAL PRINCIPLES and PATH-FINDING. In that respect I claim to stand high also in the Philosophy of Power. Long before the sixth volume is finished, readers will appreciate the new ideas and valuable general principles that distinguish The Philosophy of Power. There has been nothing like the flow of new ideas in The Philosophy of Power before or since Herbert Spencer wrote his wonderful Synthetic Philosophy". D.M.

There is a copy of his book in the British Museum, shelved at 8471.f.14. Also a copy in the Wellington City Library, 90% of it. I do not recollect the occurrence of the words love, marriage, wife or sex.

Short notes from various sources.

"I had gone through the New Zealand and afterwards Sydney Universities, and for my degree I took logic among other subjects. That set the ball rolling and it has been rolling ever since, a matter of 22 years."

"I spent 12 years and some thousands of pounds in developing the Murray Automatic, my high-speed typewriter, which worked at nearly 200 words (1200 letters) a minute."

An advertisement in 1923 in the Telephone Journal says: "The Murray Multiplex is the Rolls Royce of Printing Telegraphs in performance, but not in price."

In the Telegraph and Telephone Journal of November 1914 Murray states the basis of his complaint against the Western Electric Company.

There is a letter in "Nature" from him on 12th June, 1888 on the subject of the Periodic Law, with reference to some curves he drew and the position of Beryllium. Another in "Nature" of 24th February 1934 on "The Infinite and Eternal Energy".

From the Auckland Library: "We have rolls for the Auckland College and Grammar School for the years 1875, 1876 and 1877 and I have found from these that Donald Murray attended the school in those years and won several prizes."

The Sydney Morning Herald had no obituary notice about him, "perhaps because of the newsprint shortage and skeleton size of the paper during the war."

The National Reference library in London has given me a list of his patents from 1893 to 1925, and of the addresses during that time. The last was his factory at 55, Goswell Road, London.

The Headmaster of Auckland Grammar School wrote: "Donald Murray entered Auckland Grammar School in February 1880, and, according to our records, left in June 1881. Academic records do not appear to have been kept in permanent form until 1882."

The 14th Edition of the Britannica (mainly American) mentions Donald Murray twice in Volume 21, page 886.

The archivist of the University of Sydney wrote: "Murray applied to sit for the Master of Arts Examination in logic in 1892. A copy of a letter (now almost illegible) of Feb 1892 from the University to Murray appears to refer to an illness suffered by Murray, but apparently he completed the examination requirements, and he was admitted to the degree of Master of Arts in the School of Logic, Mental and Moral Philosophy, and Political Philosophy on 23rd April 1892.

I wrote to Territet, Switzerland, and the Registrar replied: "Donald Murray. E'poux de Patricia, nee Cosgrave, sans domicile fixe, en sejour a Veytaux... l'etat civil n'enregistre pas la cause du décès, nous l'ignorons donc; nous ignorons egalement quel docteur soignait Monsieur Murray. Nous nous sommes renseignes a la police de Veytaux, malheuresement elle n'a que les pieces depuis 1947 dans les archives."

Finally, Kinsfolk! There is his photograph! Study it well!

I have passed on to you everything I have learned about Donald. There has been a postal strike here for nigh on seven weeks, and at least one letter is due to me from New Zealand, from Ethel Elizabeth Robertson. If there is anything of great importance, and new, I will append it to this page.

The Rutherglen Murrays

How little we know about them! How little their descendents know about them! How difficult it now is to obtain answers to the questions we would like to ask! Famous enough in their times, locally, and even in a national and indeed international scene, one has to seek widely for a record of their work. We can piece together a little about Donald The Provost and his private life, but of the interesting private lives of his son and grandson there remains little, almost nothing. But we can speculate, and we can ask questions!

From John Murray I of Inchure we trace four men in successive generations, each possessed of energy and capacity for work and increasing responsibility. John Murray II did not make a success of his journey to Glasgow, and returned to end his days near the village of Bonar Bridge. His son, Donald, after being in the Vale of Leven and doing well there, turned his eyes to the larger town of Rutherglen, achieving a fine local reputation, which only endures in these badly typed pages. But ambition increases with the next generation, and John becomes a national figure in New Zealand.

With this drive to make good, and better education, the size of the families decreases, we learn less about the private lives of the individual. About Donald The Inventor we can only record from the available evidence that he lived in the best hotels all over the wide world, never settling for long anywhere, pushing his inventions wherever there appeared to be a market for them. He became rich. Apparently he did not marry until the age of 47. There is no record of him having a family, or of him visiting relations. Ambition is still driving him on and at the age of 74 he published the first of a projected series of six books on Philosophy - at an age when men should not be writing books! (I'm 74! RLM).

The character of the Inventor seems a complicated one compared with the straight-forward one of his father. I read Donald's book with a biased and clinical eye, for I knew beforehand from the Journal of the Institute of Electrical Engineers from which I have quoted that he showed signs of brain trouble within a year of its publication. What was the diagnosis of those French surgeons who operated upon him thrice? And he thereafter survived four years to die at age 80, in Switzerland, and "of no fixed address", a wanderer still, with his wife of 1912, Patricia Cosgrave (an Irish name?). I think it could not have been a cerebral tumour. But he certainly had some grandiose ideas. His self-confidence was immense. He did not like criticism. I am not much of a psychiatrist, but if your are one, get the book from the library and make your own assessment.

And a career of 12 years in Journalism! Did Donald believe all that stuff about his remote ancestry which he quoted at such length in the appendix?

What do you think of the photos of father and son which accompanies this sketch?

The Inventor would appear to be the last of his line. Nobody knows whether he ever had a family or not.

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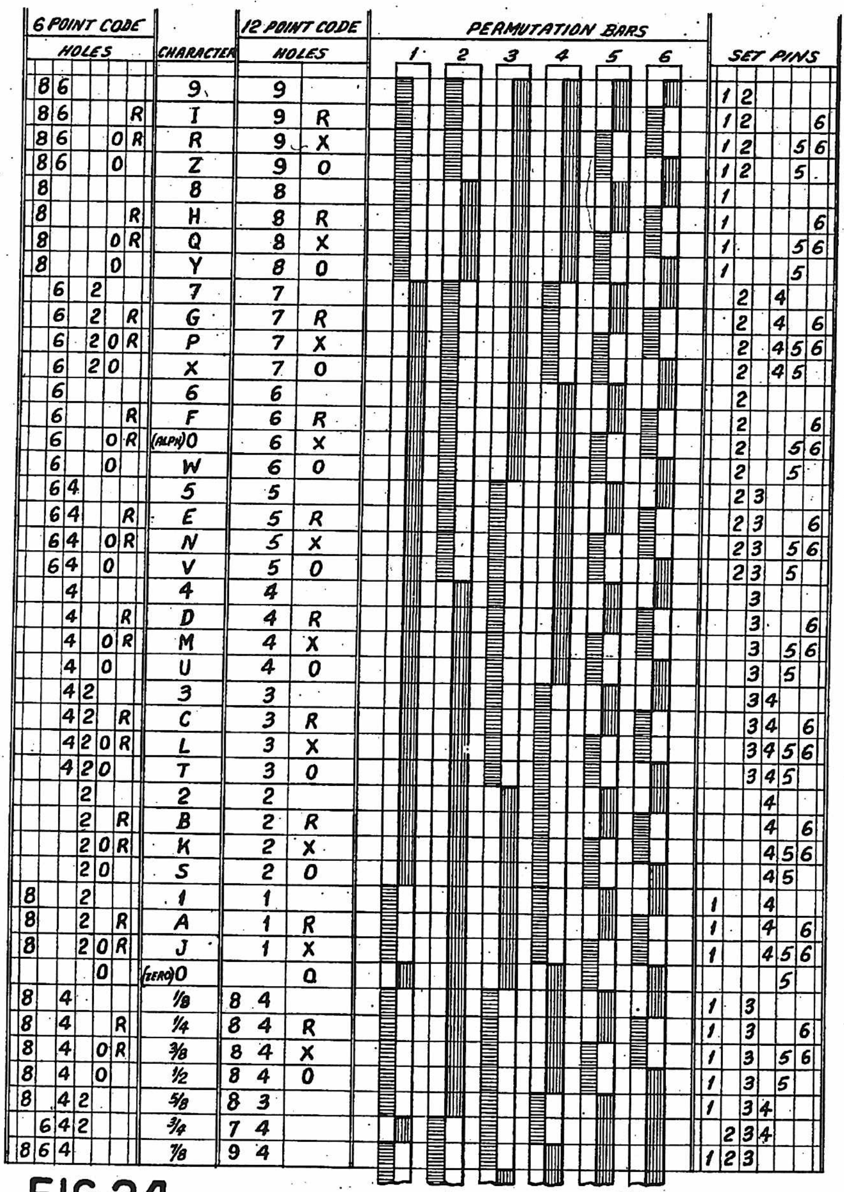
April 9, 1946. R. E. PARIS 2,398,036

PRINTING MECHANISM

Filed April 21, 1943 17 Sheets-Sheet 16


PERMUTATION BARS
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6 POINT CODE HOLES						CHARACTER	12 POINT CODE HOLES		SET PINS					
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8	6			0	R	R	9	X	1	2			5	6
8	6			0		Z	9	0	1	2			5	
8						8	8		1					
8					R	H	8	R	1					6
8				0	R	Q	8	X	1				5	6
8				0		Y	8	0	1				5	
	6		2			7	7			2		4		
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	6	4		0	R	N	5	X		2	3		5	6
	6	4		0		V	5	0		2	3		5	
		4				4	4				3			
		4			R	D	4	R			3			6
		4		0	R	M	4	X			3		5	6
		4		0		U	4	0			3		5	
		4	2			3	3				3	4		
		4	2		R	C	3	R			3	4		6
		4	2	0	R	L	3	X			3	4	5	6
		4	2	0		T	3	0			3	4	5	
			2			2	2					4		
			2		R	B	2	R				4		6
			2	0	R	K	2	X				4	5	6
			2	0		S	2	0				4	5	
8			2			1	1		1			4		
8			2		R	A	1	R	1			4		6
8			2	0	R	J	1	X	1			4	5	6
				0		(ZERO) 0		0					5	
8		4				1/8	8 4		1		3			
8		4			R	1/4	8 4	R	1		3			6
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FIG. 34.

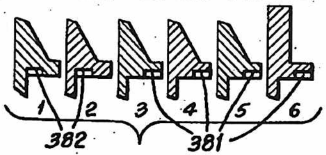


FIG. 35.

INVENTOR
Robert E. Paris
BY
W. M. Wilson
ATTORNEY

FIG. 28.

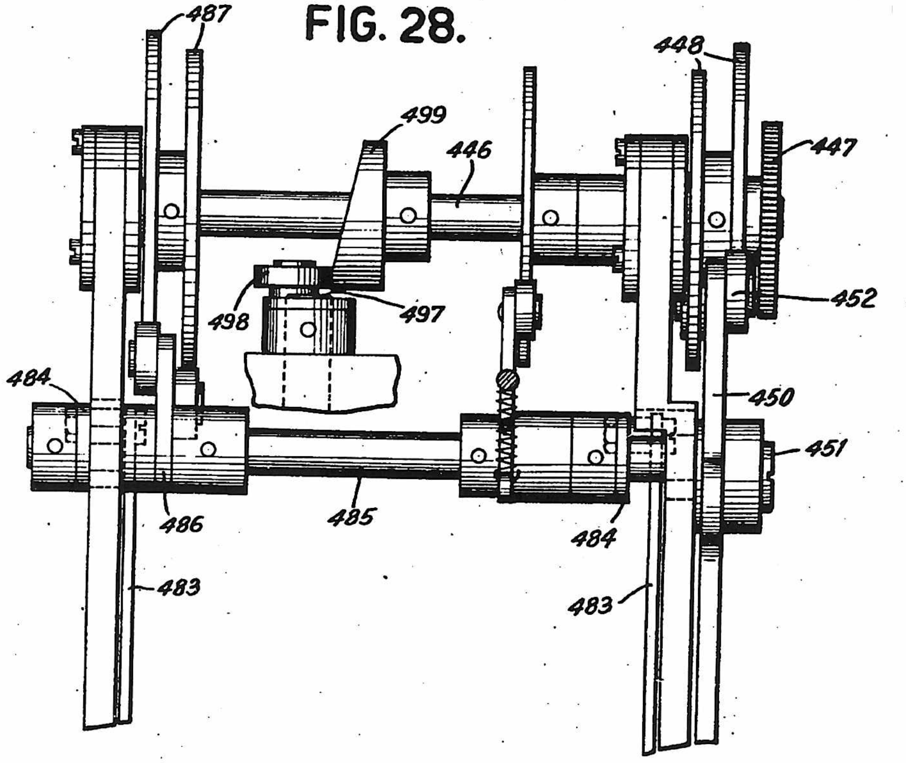
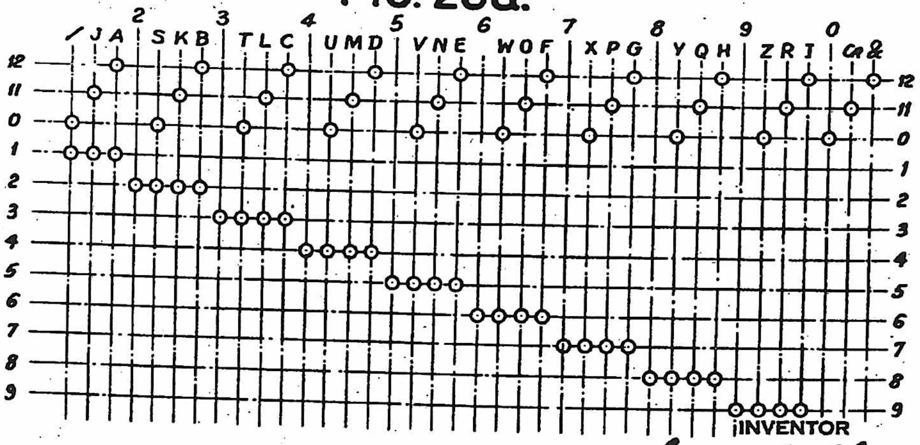


FIG. 28a.



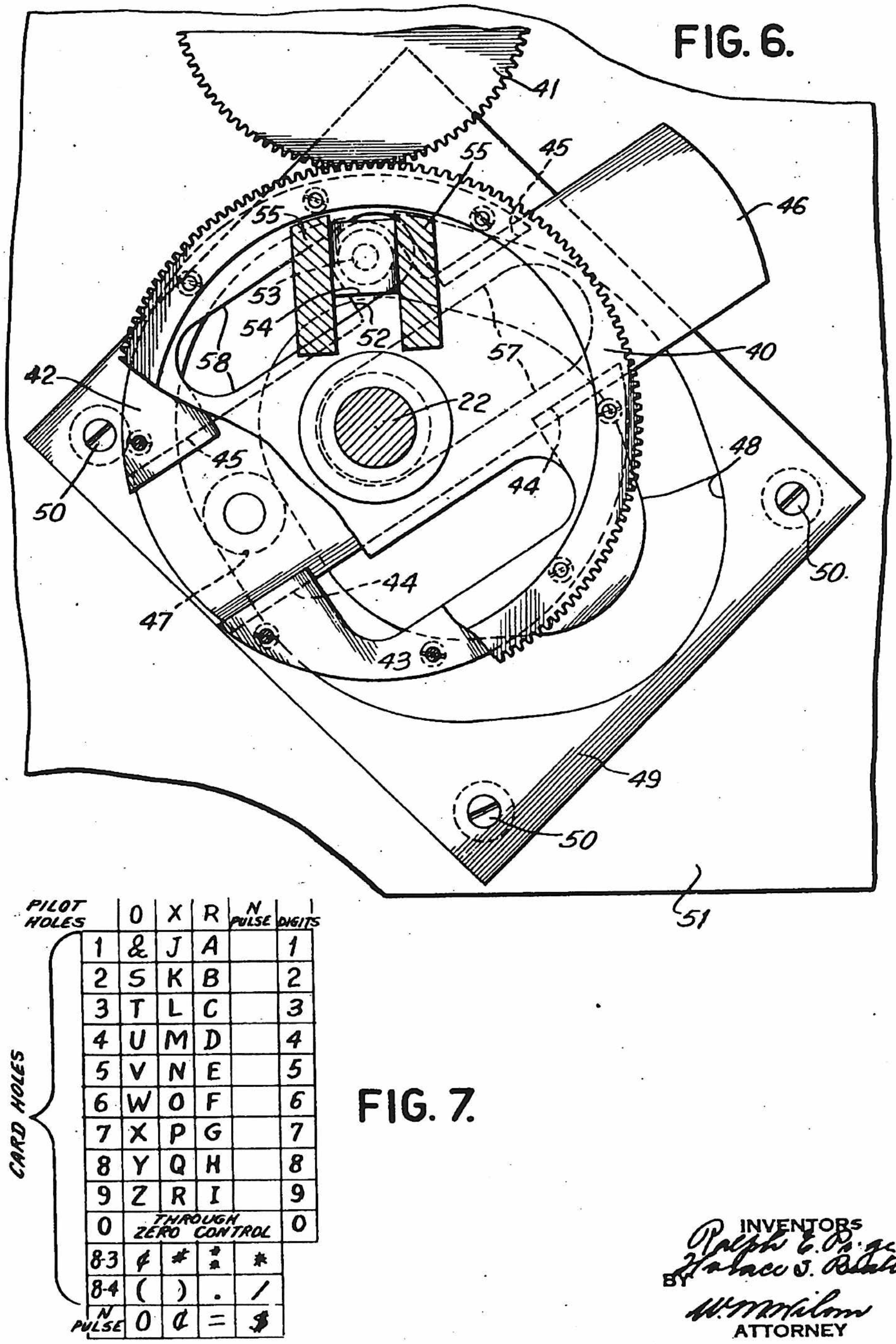
INVENTOR
Eugene Buhler
BY
W.M.Wilson
ATTORNEY

March 16, 1948. R. E. PAGE ET AL **2,438,071**

PERFORATED CARD CONTROLLED ALPHABET AND NUMERAL PRINTER

Filed Dec. 23, 1944 9 Sheets-Sheet 6

FIG. 6.



CARD HOLES

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3	T	L	C		3
4	U	M	D		4
5	V	N	E		5
6	W	O	F		6
7	X	P	G		7
8	Y	Q	H		8
9	Z	R	I		9
0	THROUGH ZERO CONTROL				0
8-3	¢	#	:	*	
8-4	(	)	.	/	
N PULSE	0	¢	=	$	

FIG. 7.

INVENTORS
Ralph E. Page
Wallace J. Beattie
BY
W. M. Wilson
ATTORNEY

Sixth Plenary Meeting of the C.C.I.T., Brussels, May 1948

U.D.C. 654.1

THE fifth plenary meeting of the C.C.I.T.[1] was held at Warsaw in October, 1936, and at the close of that meeting it was agreed that the next plenary assembly would be held concurrently with a plenary assembly of the C.C.I.F. at Lisbon in 1940. However, events arranged otherwise, and although advantage was taken of a C.C.I.F. meeting at Paris, in 1946, to hold a short special meeting of the C.C.I.T. to elect principal reporters for the committees which were previously directed by the German administration, and although preparations were then in hand for the next plenary meeting to be held in 1947, various matters arose which required further postponement of the plenary meeting until 1948.

Although the plenary meeting was postponed much work had been done in the meantime to ensure collaboration between the various administrations, particularly with the drafting of regulations which would apply to the working of the International Telex system, a system still in its infancy but already of such stature that it allows of a private subscriber in London, for instance, communicating by means of his teleprinter to other similarly equipped subscribers in France, Holland, Belgium, Switzerland and Czecho-Slovakia.[2] A meeting of the committee charged with this task was held at The Hague in 1946, and a meeting of a committee charged with the task of remodelling the committees to suit the questions facing the C.C.I.T. was held in 1946 at Paris.

The plenary meeting at Brussels had to deal with all the questions left over for study by the meeting at Warsaw and with all new questions which had arisen in the period following that meeting and with the telex regulations. The new questions included, amongst others, the American proposal for the general recognition of the International Alphabet No. 2, with certain suggested minor modifications to that Alphabet, and the British proposal for the utilisation of signal No. 32 of the No. 2 Alphabet, a signal which at present is barred for international use.

The actual meetings were held at the Egmont Palace, a large mansion in its own grounds, which at one time was a private residence, but is now the property of the town of Brussels. The arrangements made for the meetings were most convenient, all the rooms being situated on the first floor of the building. Two of the largest rooms were equipped for simultaneous translation, and served for the main meetings of the various committees ; the smaller rooms were used for the meetings of the sub-committees and here the successive method of translation was used.

The work of the plenary meeting was divided into six committees : Technical, Operations, Organisation, Subscribers Service (Telex), European Network and Drafting. Because of the number of committees the meetings were arranged so that there was a minimum of overlapping. The arrangement was perhaps too rigid in its conception and led in the final stages of the meeting to very late and prolonged meetings of some of the committees and in particular, the Technical Committee. There will not be, however, another assembly of the C.C.I.T. organised in this manner since the arrangements provided for under the Atlantic City Convention require that the separate committees reach their conclusions in advance of any plenary assembly and any lesson to be learnt from the experience at Brussels cannot be applied to future meetings of the C.C.I.T.

The Technical Committee had to deal with questions arising out of six of the committees of the C.C.I.T., these dealing with (1) quality of telegraph transmission, (2) standardisation of telegraph apparatus, (3) relays, (4) co-existence in cables of telegraph and telephone circuits, (5) phototelegraphy, (6) protection, and all matters which could not be treated in the main committee were dealt with by sub-committees under the chairmanship of the principal reporters of these C.C.I.T. committees.

It can be stated that the Technical Committee worked most harmoniously and the British delegation has the satisfaction of knowing that in the main the resulting opinions and new questions were in direct line with their experience and opinions expressed in the preliminary documents. Agreement was reached on definitions of telegraph distortion and margins which will replace the definitions in the present opinions of the C.C.I.T. Agreement was reached on the detail of circuit advices to be exchanged between Administrations whenever new international telegraph circuits were set up and on the precise functions of certain testing offices on the route of such circuits, this being based mainly on the practice which has been evolved in this country. Agreement was reached also on the method to be adopted for bringing into operation a reserve circuit when, for any cause, an international telegraph circuit is found to be unworkable; again the procedure adopted was based on the experience gained and practice adopted in this country.

Much discussion centred in the proposition of the United States that the Telegraph Regulations should contain a paragraph advocating the adoption, with reservations, of the 5-unit code Alphabet No. 2, as the code for general use in international telegraphy, and after some modifications to the wording of the U.S. proposal, which were accepted by the U.S. representative, the proposal was accepted. This proposal had its origin in the deliberations of the Bermuda Conference.

Another question which gave rise to much discussion was the British proposal that the 32nd signal of the Alphabet No. 2, the all space signal, which is at present not used internationally, should be reserved for the possible use of a third case shift on teleprinters and thus make available another series of signals which would possibly be required in the future when teleprinter working is much more developed by commercial users. This question was originally raised by

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[1] *P.O.E.E.J.*, Vol. 29, p. 293.

[2] *P.O.E.E.J.*, Vol. 41, p. 39.

The Post Office Electrical Engineers' Journal July 1948 vol 41 part 2 the Creed Co. and supported by the British administration who raised the matter in the form of a new question to the C.C.I.T.

The question received general support and agreement was reached that the original question should be studied as a new question in a new general form with the British proposition as a particular case.

The main purpose of the question was to bring to the attention of Administrations the idea that there were real possibilities in the usage of this signal for the purpose of a third case, and that it would not be wise to use this signal for special national purposes which might stultify its wider use in the future.

Numerous other questions were dealt with, some matters of detail, some of much wider significance, but all were resolved or remitted for further study. Such questions included the design and utilisation of regenerative repeaters, involving the desirability or otherwise of a stop signal longer than 1 unit, e.g. 1½ units; the blocking of the keyboard of a teleprinter after the number of letters allocated to a line has been operated; the utilisation of the full band available on coaxial cable telephone circuits for phototelegraphy and the repercussion on the design of the phototelegraphy apparatus; the use of sub-carrier frequency modulation as the transmission method for phototelegraphy over lines; standardisation of paper sizes and line spacing on page teleprinters. In all some forty new technical questions were passed for future study by the C.C.I.T., in many cases in combination with C.C.I.R. or C.C.I.F., and a recommendation made that a permanent sub-committee should be set up to deal with all questions of maintenance on the lines of a similar committee in the C.C.I.F.

The draft regulations for the operation of the International Telex service were discussed in detail and were finally agreed.

The matter of a European switched network for the more expeditious handling of public telegrams which could not be dealt with by direct circuits, which originally had been raised by the Czechoslovak Administration, was discussed, and it was agreed that there was need for such a network and that further study should be made of the problem on the basis of an agreed memorandum which will be incorporated in the recommendations of the Conference.

At the Plenary Conference Great Britain was charged with the chairmanship of two technical committees, one dealing with phototelegraphy and the other with the technical questions of automatic switching.

F. E. N.

Institution of Post Office Electrical Engineers

Result of Ballot on the Proposed Alterations to Rules.

The Scrutineers have reported to Council the result of the ballot, on the proposals put to the membership in April last.

It is as follows :—

	For the Amendment	*Against the Amendment*
(1) Membership ; Rule 6. Associates	767	1,171
(2) Subscription : Rule 13	1,216	718

(Total membership eligible to vote was 5,017.)

In accordance with the provision of Rule 31, the proposal under (1) will not be brought into effect.

The proposed rates of subscription will be operative this session, and members will have seen the notices which appeared in the Post Office Circulars of the [illegible]th April and 2nd June, 1948, in regard thereto.

ESSAY COMPETITION, 1948-9

The Council offers Five Prizes of Three Guineas each for the five most meritorious Essays submitted by members of the Engineering Department of the Post Office below the ranks of Inspector and Draughtsmen Class II, and, in addition, to award a limited number of Certificates of Merit.

A prize-winner in any previous competition is not eligible to enter, but this restriction does not apply to a competitor who has been awarded a certificate only. An essay submitted for consideration of an award in the Essay Competition and also submitted in connection with the Junior Section I.P.O.E.E. prizes, will not be eligible to receive both awards.

In judging the merits of an essay, consideration will be given to clearness of expression, correct use of words, neatness and arrangement, and although technical accuracy is essential, a high technical standard is not absolutely necessary to qualify for an award. The Council hopes this assurance will encourage a larger number to enter. Marks will be awarded for originality of essays submitted. Competitors may choose any subject relevant to current telegraph or telephone practice.

The Essay must be written on foolscap or quarto paper, and must not exceed 5,000 words. A ¾-in. margin to be left on each page. A certificate is required to be furnished by each competitor, at the end of the essay, in the following terms :

> *" In forwarding the foregoing essay of ....words, I certify that the work is my own unaided effort both as regards composition and drawing."*
>
> *Signature* ....
>
> *Address*..
>
> *Date* ....
>
> *Rank*..

The Essays must reach The Secretary, The Institution of Post Office Electrical Engineers, G.P.O. (Alder House), London, E.C.1, by the 31st December, 1948.

J. Reading, *Secretary.*

March 15, 1949. E. J. RABENDA ET AL **2,464,608**

RECORD CONTROLLED PRINTING APPARATUS

Filed Jan. 24, 1946 16 Sheets-Sheet 5

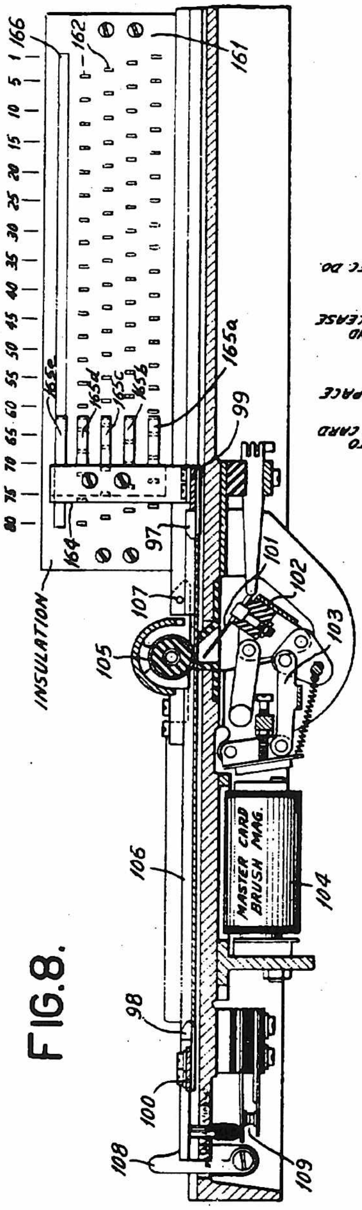


FIG. 8.

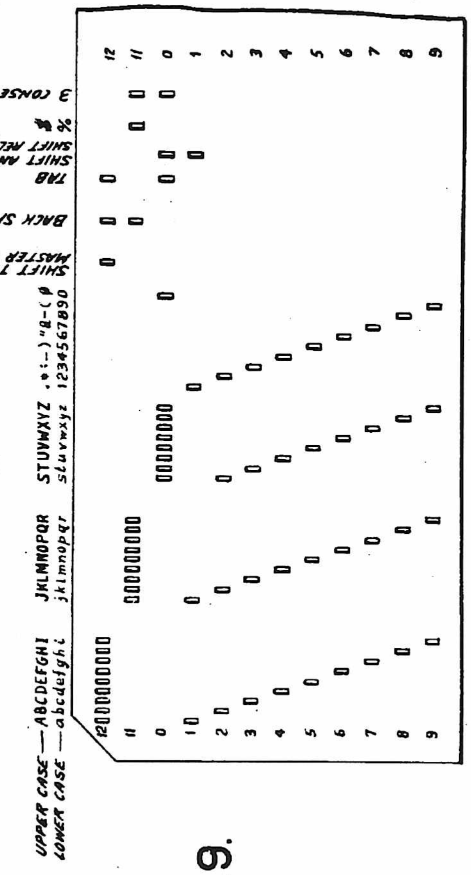

12
11
0
1
2
3
4
5
6
7
8
9
3 CONSEC. DO.
%
SHIFT AND SHIFT RELEASE
TAB
BACK SPACE
SHIFT TO MASTER CARD
UPPER CASE — ABCDEFGHI JKLMNOPQR STUVWXYZ .*:-)"&-(
LOWER CASE — abcdefghi jklmnopqr stuvwxyz 1234567890

FIG. 9.

INVENTORS
E. J. RABENDA
F. J. FURMAN
BY
W. M. Wilson
ATTORNEY

Jan. 10, 1950 F. M. CARROLL ET AL 2,493,858

ALPHABET PRINTING TABULATOR WITH PROGRAM CONTROLS

Filed Nov. 28, 1942 36 Sheets-Sheet 35

FIG. 51.

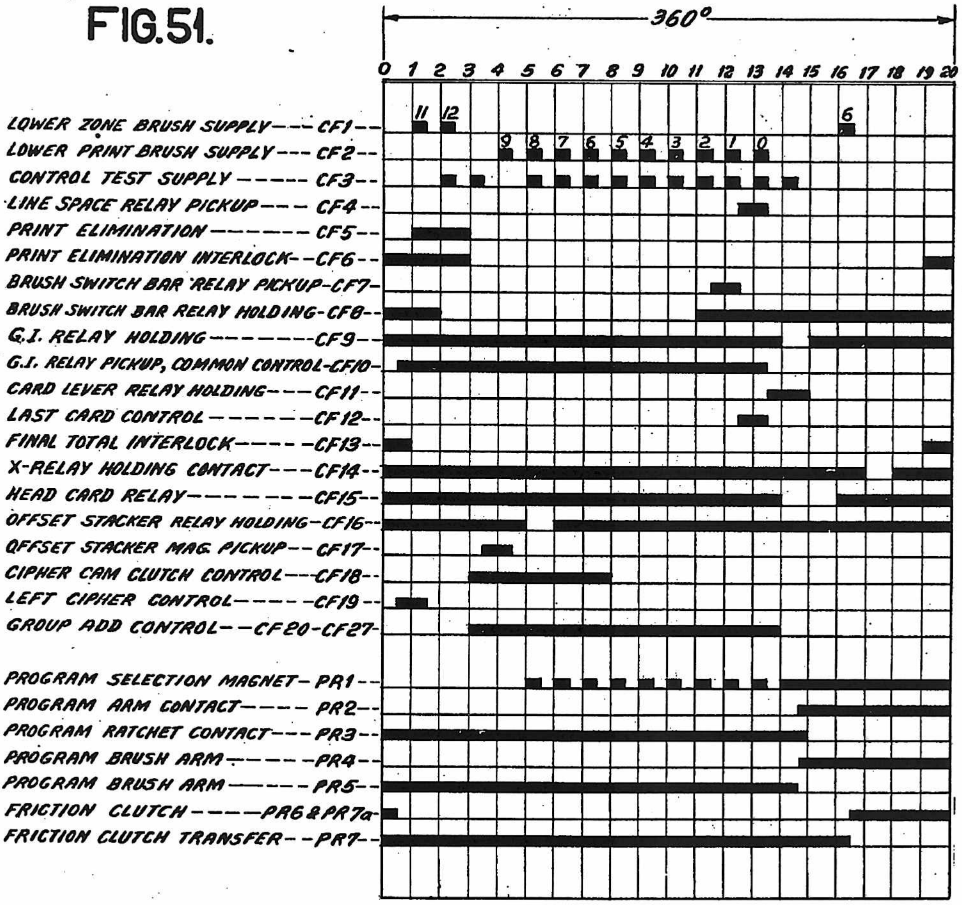


FIG. 51a.

BRUSH IMPULSE		11	12		9	8	7	6	5	4	3	2	1	0		
PRINT DIGIT 11&12 12 11						9 Z I R	8 Y H Q	7 X G P	6 W F O	5 V E N	4 U D M	3 T C L	2 S B K	1 @ A J	0 % - #	

Fred M. Carroll
Arthur F. Smith
INVENTORS

BY

ATTORNEY.

Oct. 3, 1950 R. B. JOHNSON 2,524,127

PRINTING CHARACTER FORMING WIRES

Filed Nov. 6, 1946 11 Sheets-Sheet 6

Fig. 8.

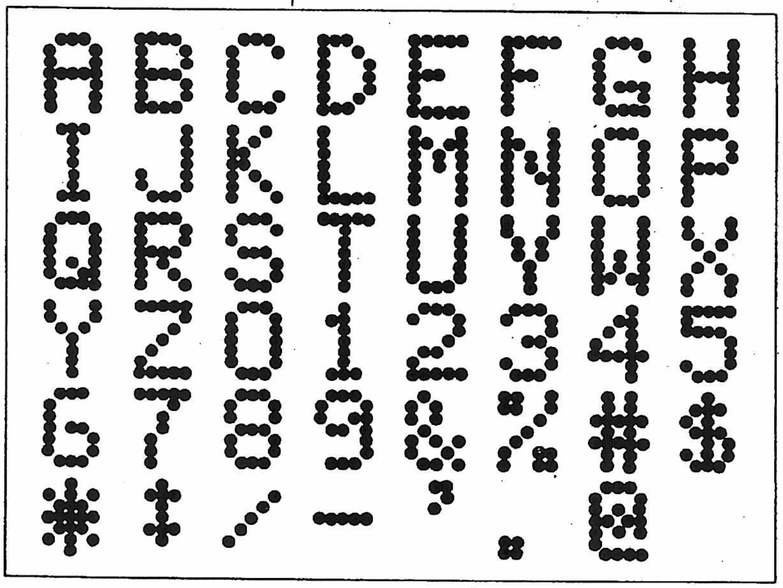
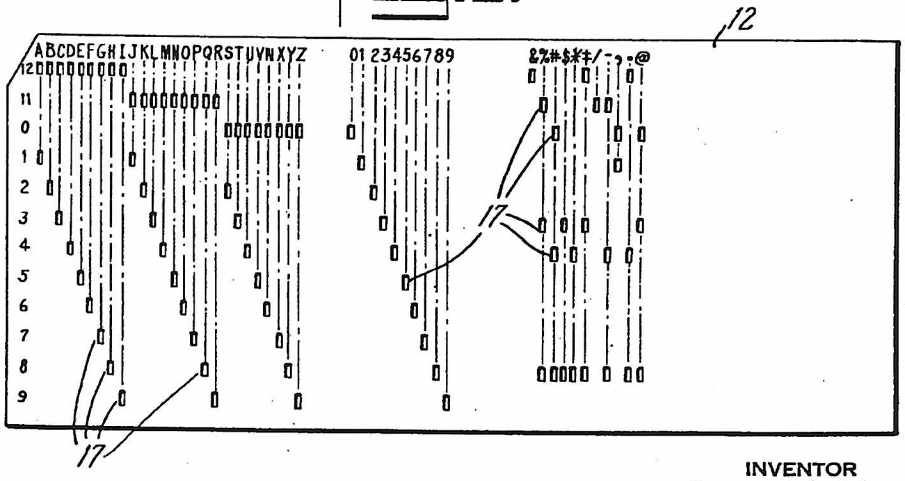


Fig. 9.



INVENTOR
Reynold B. Johnson
BY William Lang
ATTORNEY

PRINTING CHARACTER FORMING WIRES

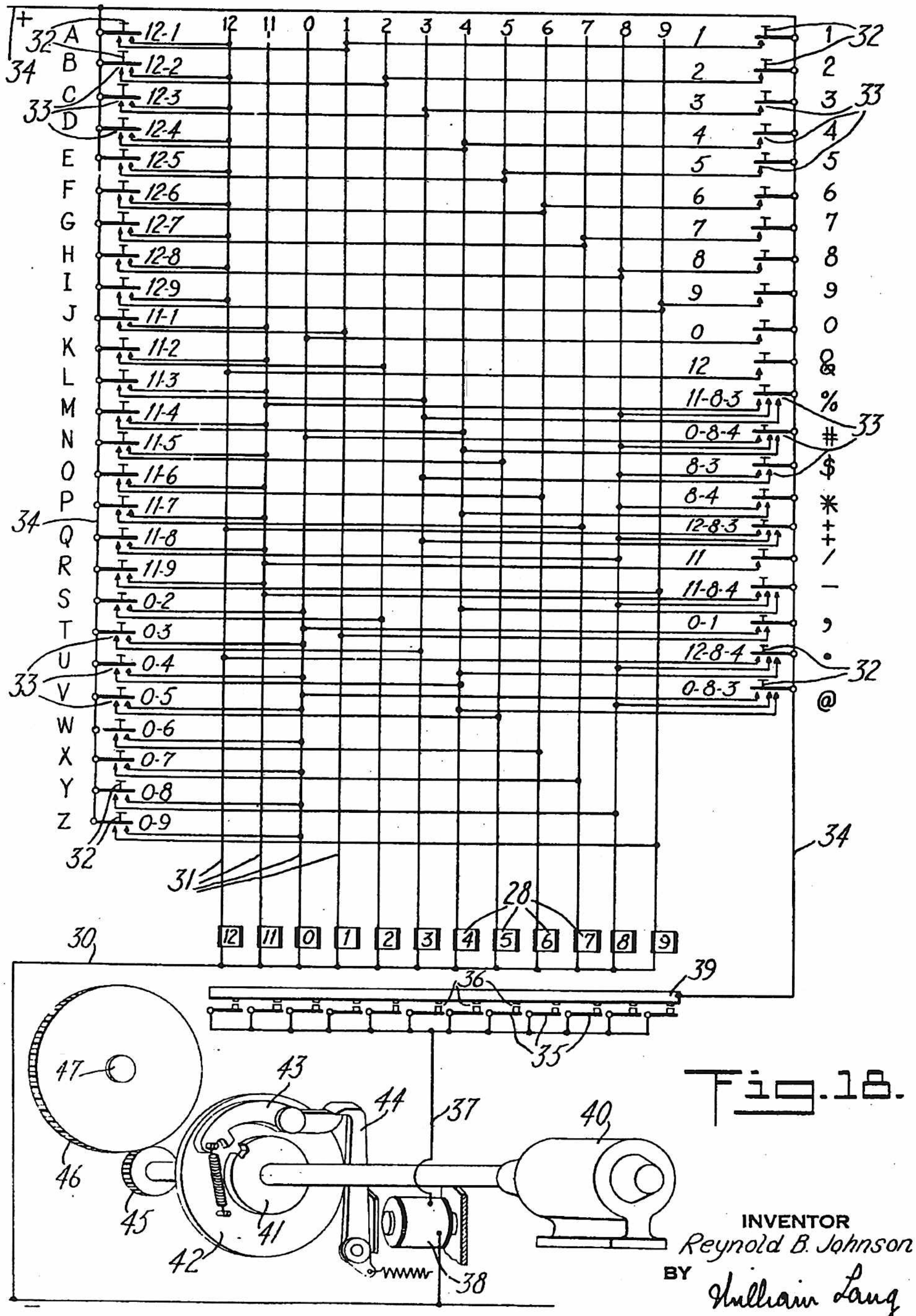


Fig. 18.

INVENTOR
Reynold B. Johnson
BY
William Lang
ATTORNEY

International Business Machines Corporation

IBM

407

accounting machine

manual of operation

JUN 12 1961
LIBRARY

PRINT UNIT

PRINTING on the Type 407 is accomplished by means of 120 print wheels arranged in a solid bank which prints within a width of 12 inches, 10 characters to the inch. Each print wheel contains the following 47 separate character positions (Figure 5):

10 digits: 0 through 9
26 letters: A through Z
11 special characters:
/ $ ¤ * % @ & – # . ,

As shown in Figure 5, the print wheel is divided into twelve equal parts:

Digits 1 through 9	9 parts
Combination of the digits 8 and 3 in one column	1 part
Combination of the digits 8 and 4 in one column	1 part
Zone only	1 part

Each of the twelve parts is in turn divided into four sections:

0 Zone
11 Zone
12 Zone
N (no) Zone

As shown in Figure 6, the 0, 11, and 12 zones control the printing of 26 letters, zero, and nine special characters. The N (no) zone controls the printing of nine digits and two special characters.

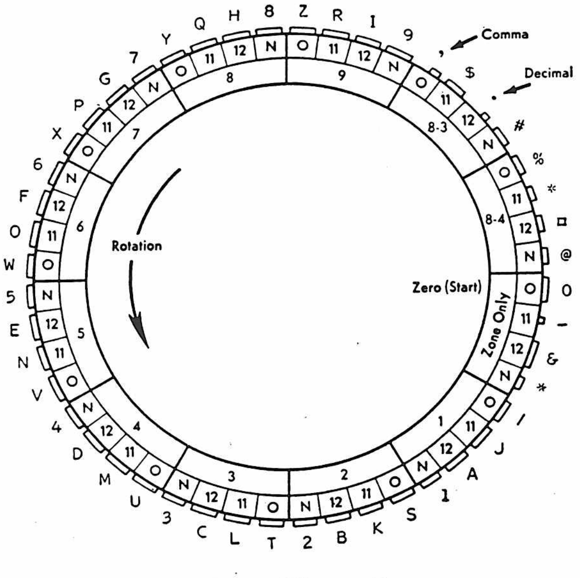


FIGURE 5. PRINT WHEEL SCHEMATIC

LOWER PUNCH	ZONE 12	11	O	N
1	A	J	/	1
2	B	K	S	2
3	C	L	T	3
4	D	M	U	4
5	E	N	V	5
6	F	O	W	6
7	G	P	X	7
8	H	Q	Y	8
9	I	R	Z	9
8–3	.	$	,	#
8–4	¤	[1] *	%	@
	&	–	0	[2] *

1. Total Symbol 2. Check Protection

FIGURE 6. CHARACTER CODES

An additional special character (*) position is provided for check protection.

The print wheels remain stationary until the digit punched in the card is read, at which time one of the twelve sections is selected. A further selection of one of the four parts within that section is made when the zone is read. The printing wheel rotates at a high rate of speed until printing time, when its speed is reduced to 25% of normal. At the actual time of printing the wheel is moved forward against the platen in a straight line motion, which produces maximum legibility. The rotary motion of the wheel at print time is compensated for by a special cam.

Although one line is printed on one cycle, the wheels print at four different times within that cycle. All of the wheels zoned for 0 print first, followed in succession by those for 11, 12 and N.

Speed

The Type 407 operates at a speed of 150 cards per minute (9,000 cards per hour). With 120 wheels for printing, the maximum printing speed is 18,000 characters per minute. The same speed is maintained for accumulating totals for group printing, total printing, crossfooting, or taking special program cycles for other operations.

OPERATING KEYS, SWITCHES, AND SIGNALS

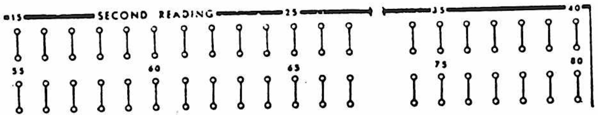
SWITCHES and signals for controlling machine operations are shown in Figure 7.

DETAIL PRINTING

THE TYPE 407 is basically a detail printing machine. Detail printing is the printing of information from each card as it passes through the machine. Figure 11 shows the codes that must be punched in the card to print digits, letters and special characters. The digits 0 through 9 are identified by single punches, while the letters and special characters are identified by combination punching. For example, the combination of 12 punches with the digits 1 through 9 are recognized by the machine as the letters A through I. Combinations of 11 punches with the digits 1 through 9 are recognized by the machine as the letters J through R. Combinations of 0 punches with the digits 2 through 9 are recognized by the machine as the letters S through Z. Eleven special characters are designated by various combinations of punches as shown in Figure 11. These are permanently assigned codes and when the control panel is properly wired, the machine will always recognize a 12-1 as the letter A, 0-4-8 as the % sign, etc.

As previously explained, each one of the 120 print wheels may be impulsed to print any one of the 47 characters shown on the card in Figure 11. Only one wire on the control panel is needed to print a number, a letter or a special character.

Underpunching cannot be used as a means of correcting cards when they are to be processed through the 407.



G-H, 1-40;
AC-AF, 1-40

Second Reading. There are two sets of second reading hubs, one in the left center of the control panel and the other at the left top of the panel. The corresponding hubs in both sets are common and can be used interchangeably. The 80 second reading hubs represent the 80 columns on the cards and are used for all normal reading operations. In order to print information that is punched in the card, the second reading hubs corresponding to the card columns are wired to normal print entry. They may also be wired to transfer print entry or counter-controlled print as explained under the discussion of those hubs.

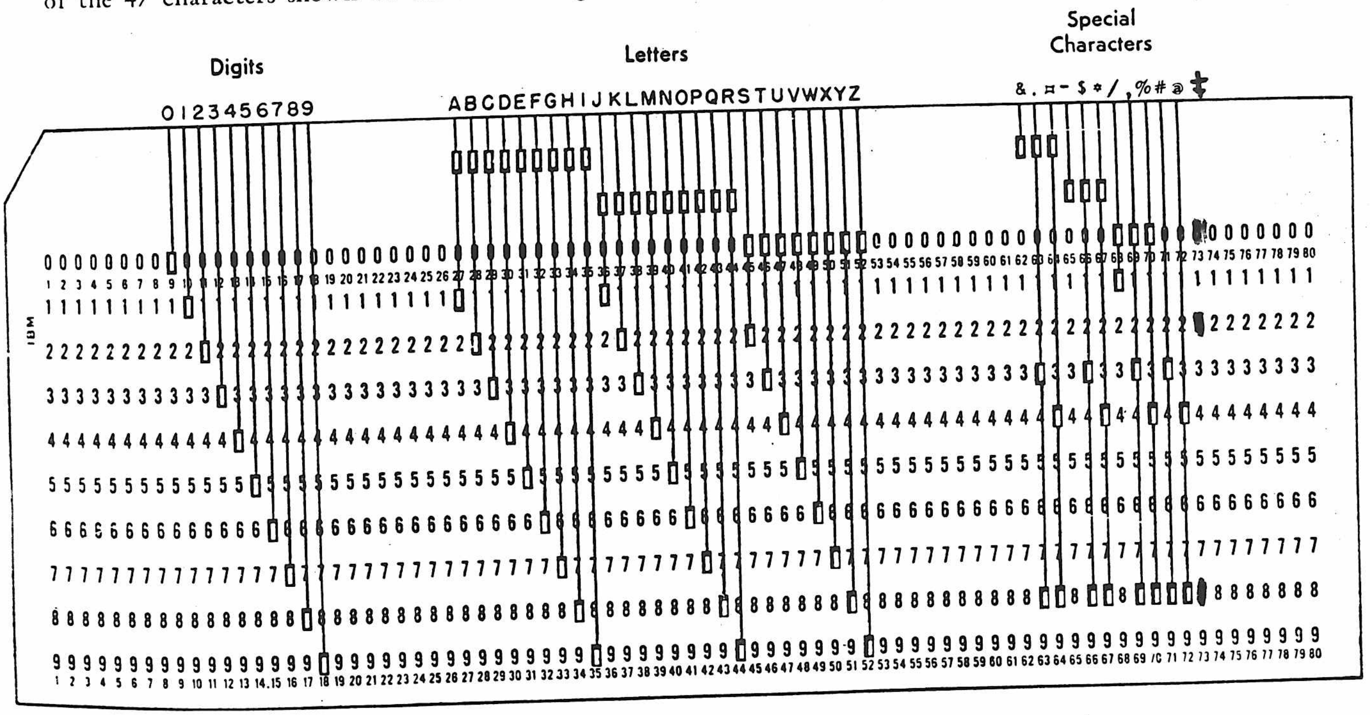


FIGURE 11. CHARACTER PUNCHING